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Title: The Space of Aerospace Power – Why and How

APPROVED AS SAF PAS #: 00—0302

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
01MAY2000	N/A	-

Title and Subtitle The "Space" of Aerospace Power: Why and How	**Contract Number**
	Grant Number
	Program Element Number
Author(s) Billman, Gregory M.	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Air Force Fellows Program Maxwell AFB, Al 36112	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes	
Abstract	
Subject Terms	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 253	

THE "SPACE" OF AEROSPACE POWER:

WHY AND HOW

A THESIS PRESENTED TO

THE AIR STAFF, AIR UNIVERSITY,

THE INSTITUTE OF INTERNATIONAL SECURITY STUDIES, AND

THE RIDGWAY CENTER FOR INTERNATIONAL SECURITY STUDIES

FOR COMPLETION OF GRADUATION REQUIREMENTS

BY

LIEUTENANT COLONEL GREGORY M. BILLMAN, USAF

NATIONAL DEFENSE FELLOW

GENERAL RIDGWAY CENTER FOR INTERNATIONAL SECURITY STUDIES

UNIVERSITY OF PITTSBURGH

MAY 2000

DISCLAIMER

ABOUT THE AUTHOR

Lieutenant Colonel Gregory M. Billman (BS, Arizona State University; MS, Missouri State University; MAAS, School of Advanced Airpower Studies [SAAS]) is an "aerospaceman." He has held duties as a fighter weapons instructor, F-111A/D/E and F-15E weapon systems officer, as well as as a space and missile operator, and space squadron commander. After commissioning in 1983, he attended Minuteman II ILCS launch officer training at Vandenberg AFB, California, and was transferred to Whiteman AFB, Missouri, in the 508th Strategic Missile Squadron, 351st Strategic Missile Wing. He became an instructor missileer and upgraded to crew commander prior to attending Undergraduate Navigator Training (UNT) in September of 1985.

He was the Top Graduate from UNT, as well as Tactical Navigation Training and Fighter Lead-In Training, and was assigned to the F-111 Replacement Training Unit (RTU) at Mountain Home AFB, Idaho in September 1986. As a distinguished graduate from F-111 RTU, he was assigned to the 20th Tactical Fighter Wing (TFW), RAF Upper Heyford, England in May 1987. While at the 20th TFW, he upgraded to instructor WSO, was selected as the Outstanding Contributor at Squadron Officer's School, ran the squadron radar strike shop, became the wing's Chief of Flying Safety (investigating two Class A mishaps), graduated from Fighter Weapons School, was the wing's Chief of Tactics, flew as a strike mission commander in DESERT STORM, and was a flight commander in the 77th Tactical Fighter Squadron prior to being selected to attend F-15E transition training in May of 1991. Graduating as the WSO Top Gun from F-15E RTU, he was assigned to the 4th Wing, Seymour Johnson AFB, North Carolina as the wing's Chief of F-15E Weapons and Tactics. In that position, he led the effort to equip the F-15E with the GBU-15 precision guided munition, and participated in the development of the AGM-130 rocket powered, precision guided munition.

Lt Col Billman was a distinguished graduate from Air Command and Staff College in June 1994, where he was heavily involved with SPACECAST 2020, co-authoring a paper on force application from space, working on the Alternate Futures Group, and briefing senior leadership. As a member of the fourth graduating class of SAAS, his thesis dealt with the "Inherent Limitations of Spacepower."

Upon graduation in 1995, he was reassigned to United States Space Command as the Chief of Joint Space Force Planning and Doctrine Development, J-5X. There, he co-authored first-ever joint space doctrine and dealt with international space policy issues. As the Deputy Director of USCINCSPACE's Action Group, he was instrumental in developing the first-ever Concept of Operations study and briefing for the Military Spaceplane.

He was selected to command the Space Division, United States Air Force Weapons School, in July 1997. While there he integrated space capabilities throughout the weapons school curriculum, including direct space involvement in all aspects of Mission Employment. Lt Col Billman was then selected as a National Defense Fellow (SSS) and attended the University of Pittsburgh's General Mathew Ridgway Center for International Security Studies, graduating in June 2000. Upon graduation, he was reassigned to the Joint Chief's of Staff (J39) at the Pentagon, where he deals with space and information operations issues.

NOTE FROM THE AUTHOR

I'd like to thank all of the individuals who helped me coalesce ideas and gave me vectors in writing this thesis. The list is too long to note here, but they are all noted in the bibliography accompanying this document. They all gave greatly of their time and knowledge, with refreshing disregard for "political correctness." This is not to imply all agree with my final conclusions -- in fact, I know many will not -- but I value all of their contributions.

I'd also like to thank my family, without whom I could not have accomplished this work. My wife and daughters are my inspiration. Lastly, I thank my second family -- the United States Air Force. The opportunity I was given this year to think, and interact with civilian policy makers and academics, has been inspiring and enlightening. The National Defense Fellowship program is a valuable tool for generating fresh thought within the institutional Air Force.

This paper attempts to tackle the "why?" and "how?" questions facing the United States Air Force (USAF) vis-a-vis realizing full spacepower capabilities, i.e. not only improved force enhancement and space force support, but more importantly, space control and space force application. All this while dealing with daily, real-world issues like expanded world hotspots, aging operational fleets and infrastructure, dwindling manpower, and limited budgets.

This thesis is not a scholarly work. It is an advocacy work. This is by design. Advocacy works are designed and written to instigate change -- and change is what this paper calls for. The reader should note the differences between scholarly work accomplished to expand knowledge, and advocacy work accomplished to support change. Douhet was not a scholar; *The Command of the Air* was not a scholarly work. Mitchell was not a scholar; *Winged Defense* was not a scholarly work. They were advocacy works, written to advocate change -- changes in their populations', governments' and militaries' views and actions regarding full airpower capabilities. Interestingly, some consider their works scholarly today.

I am neither a Douhet nor a Mitchell, but, like them, I am an advocate. This is an advocacy work, written to support changes in the US population's, government's and military's (specifically USAF's) views, and hopefully actions, regarding the realization of spacepower's full potential.

I wrote this paper for two reasons: a deep belief in the political and military advantages that a full spacepower capability would realize for this country, and because I sense the USAF's future as a viable institution is tied directly to advancing spacepower capabilities.

Calls are already "out there" today for separating the missions of air and space into two different services. If this were to happen, the USAF would eventually lose its raison d'être of global strategic attack to the nation's space force. This should not occur. Because of the very nature of its potential to apply similar, yet greater, effects into the battlespace, the "space" of "aerospace" belongs in the nation's aerospace force!

Lt Col Gregg Billman, USAF
1999-2000 AF National Defense Fellow

Ridgway Center, University of Pittsburgh

PREFACE

The National Defense Fellowship offered by the United States Air Force is truly a wonderful idea. It gives senior mid-level USAF officers a chance to reflect and think, without worrying about the necessary, but sometimes mundane, every day operations and problems confronting him or her in our volatile world today.

I have had the privilege of mentoring the USAF and US Army Fellows at the University of Pittsburgh's Ridgway Center for International Security Studies for the past twenty-five years. In this time, I have had the opportunity to read many of the Fellows' fine papers written about such diverse subjects as interdiction, air refueling, women in the military, logistics, various land and air warfare tactics, etc. While interesting and worthwhile, most of these papers, by their very nature and the nature of the individuals writing them, have spun the "party line."

This one does not. Quite to the contrary, it could be considered heresy by some; heresy in the tradition of Billy Mitchell.

One might find fault in style, syntax, etc., but Lieutenant Colonel Billman's thesis is loud and clear. The present system of preparing to exploit advancing military space capabilities is not working, and is destined for greater problems, unless we acknowledge space as an equal partner with air, land, and sea. One can argue how to do it, but one will have a difficult time arguing for maintenance of the status quo.

Given what I perceive to be today's USAF organizational climate, coupled with the give and take of funding near term air improvements and advanced space power capabilities, and the author's uniquely broad experience as both an air and space operator and leader, it may be rightly assumed that this is an advocacy paper. It is, and this is not necessarily bad.

Though a work of advocacy, it is also one of scholarship. The author has taken a cue from Douhet and Mitchell in his handling of comparative space power capabilities and limitations. Above all, he is forthright and unapologetic in his assertions, and backs them up with facts and analysis. He analyzes both advantages and disadvantages, and concludes the record favors advancing the space component of aerospace power.

As others before him in the *Command of the Air* and *Winged Defense*, Colonel Billman is goading the reader for change. He calls for changes from the nation, the military, and the USAF; the latter a service he has served with distinction for the past seventeen years. His analogies with Billy Mitchell, and the other advocates of air power, are relevant. With the perspective of history, thank God for the Mitchells, the Douhets, and the Wardens -- and others -- who have had the courage to speak out.

There are two old adages that go "those who do not learn from the past are destined to relive it," and "smart people learn from others mistakes, and dumb people learn from their own." For these reasons, the reader must read this paper for what it is, a thoughtful and articulate call for change.

There is no doubt in my mind this thesis will not be well received by some because of its controversial nature. But I implore those who read it to do so with an unbiased mind, and to discuss its points at all levels. After all, it is a think piece and should be treated as such. The author should be applauded for having the insight and fortitude to write this paper, and I hope the fact he had the guts to think and write "outside the lines" does not result in a fall from grace.

Donald Goldstein, Ph.D.
Associate Dean, Ridgway Center, University of Pittsburgh

(Author of the best seller At Dawn We Slept, The Untold Story of Pearl Harbor)

CONTENTS

Chapter One

Introduction: Spacepower--Why and How?

Victory smiles upon those who anticipate the changes in character of war, not on those who wait to adapt themselves after change occurs.
-- Giulio Douhet

Some people don't want to hear this, and it sure isn't in vogue, but, absolutely, we're going to fight in space. We're going to fight from space and we're going to fight into space…. The time to define, think about, and debate how to fight in space is now.
-- General Joseph W. Ashy, former USCINCSPACE (and fighter pilot)[1]

The biggest mistake we can make today is to impede our development as a Space and Air Force.
-- General Howell M. Estes III, former USCINCSPACE (and fighter pilot)

Between 2015 and 2025 we have an opportunity to put a fleet on another sea. That sea is space. Now the Air Force in the audience are saying, "Hey, that's mine!" And I'm saying, "You're not taking it…"
-- General Charles Krulak, former USMC Commandant

Its time to fish or cut bait.
-- General Charles A. Horner, former USCINCSPACE (and fighter pilot)

Problem and Significance:

"The United States is the world's foremost aerospace power, and our space forces are essential elements of that power. The United States Air Force (USAF) is an aerospace force comprised of both air and space systems and the people who employ and support these systems."[2] Aerospace power, then, is the sum of the nation's airpower and spacepower.[3] It is the ability of the USAF to effectively steward all aspects (cultural [i.e. perspective-oriented], organizational, and fiscal) of the dual evolution of both of these powers which is in question today. To wit, recent headlines note:

> "The medium of space is one which cannot be ceded to our nation's adversaries…the Air Force must plan to prevail in the use of space."[4]…"Spacepower has become as important to the nation as land, sea, and air power."[5]…"Space has become integral to all operations we do; that's why we call ourselves an aerospace force."[6]
>
> "North Korea Developing Two-Stage Missile, Deemed Greatest Threat to U.S."[7]…"Congress Critical of Air Force's Decision to Put Off SBIRS High Launch."[8]…"Where is the Air Force's space-based missile defense development program?"[9]…"Where is the Air Force's military spaceplane program?"[10]

> "General Estes said that without a major restructuring of the service's budget and large divestitures of some parts of the Air Force's force structure, the service can 'kiss the space mission goodbye'"[11]…"Air Force Future in Space Remains Under Fire."[12]…"Will the Air Force Lose Its Space Program?"[13]…"Smith Calls for New Space Force, 'Offensive' Use of Space."[14]

A cursory review of recent media articles notes that much is being discussed reference the aggressive pursuit of spacepower capabilities.[15] The same review yields the distressing notion the USAF is being ridiculed about its stewardship of its own self-stated priority to be the nation's aerospace force, i.e. advancing both air *and* space power capabilities.

That said, many articles point to the innovative things the USAF is doing to integrate space into air operations, i.e. becoming ever-more effective in supporting terrestrial air operations with space-borne capabilities. However, the overwhelming critique is the USAF is not paying much attention to the lesson from its own *New World Vistas* study:

> "For the U.S. to sustain its superpower status it will become necessary not only to show global awareness through space-based information, *but also to be able to project power from space directly to the earth's surface or to airborne targets with kinetic or directed energy weapons.*"[16] (emphasis by author)

This perception may exist for a multitude of reasons, but two possibilities seem especially worthy of study:

- There is a lack of institutional internalization and comprehension of the strategic and operational advantages of spacepower[17] by the military, in general, and the USAF, in particular.
- There are internal and external institutional realities (fiscal, mission-oriented, or cultural bias) hindering movement toward fully exploiting spacepower within the USAF.

In large measure, the answer probably is a factor of both of these issues. Therefore, this thesis will analyze *why aggressive spacepower development is worthwhile* in terms of influencing international actors in support of U.S. interests, and *how the military, and USAF in particular, can effectively make it happen.* In short, this thesis attempts to illustrate *why* advanced spacepower capabilities are operationally and politically advantageous, as well as analyzing *how* the USAF can make advanced spacepower a reality.[18]

Structure:

Part I:

This part addresses the first question of internalizing spacepower's operational and strategic advantages.[19] After a background discussion on various related issues in Chapter Two, Chapters Three, Four and Five frame an analysis and overarching theory of why spacepower is vitally important to our nation's security -- with the realization that forces operating in all mediums contribute to this security.[20]

Specifically, Chapter Three comparatively analyzes differing characteristics of military power as applied to air, land, sea and space forces across the spectrum of mobility -- from homebased to deployed to engaged. Chapter Four looks at how spacepower can influence (or "effect") international actors[21] -- individuals, states, and non-state organizations -- in support of United States national policy. Chapter Five's basic premise is that due to spacepower's *characteristics*, it provides *presence* in ways fundamentally different from terrestrial forces, which is fundamental to exerting *influence* in a more strategically (and politically) flexible manner.[22/23] This chapter does so by providing a model of the argument, as well as presenting a hypothetical crisis reaction by space forces -- highlighting their ability to conduct national missions with small footprints and reduced economic, military, and political risk.

Economic, military, and political realities demand the U.S. develop a capability to influence actors with the fewest negative predictable consequences. Fully capable spacepower (i.e. able to conduct all four functional mission areas of support, enhancement, control and force application) offers the potential to effectively and efficiently do so.

As an aside, though political policies exist which limit national space capabilities, no treaties exist outlawing conventional or directed energy weapons in space (except as their existence would relate to militarizing naturally occurring satellites, e.g. the moon).[24] Additionally, those who wish to view space as a sanctuary, free from warfare, are kin to those who wished to restrict airborne weapons -- well meaning, but short sighted.[25] In comparison, the consequences of neglecting our military responsibilities in space, such as allowing rogue nations to access it, are far greater due to the medium's characteristics and virtues of presence and ability to influence. If forced to play "catch-up" in controlling space, the United States will experience on a grand scale what Pickett was faced with at Gettysburg.

Part II:

This part addresses the difficult "how" issues involved with advancing spacepower within the military, in general, and the USAF, in particular. There are obvious external and internal limitations put on the USAF hindering its ability to aggressively pursue spacepower -- the most important being national policy.

The USAF is, without question, the world's greatest fighting air force. It has been, is, and will be, called upon to respond to worldwide crises, fielding and maintaining combat forces in hot spots the world over, hauling material to every end of the globe, responding to various and many humanitarian crises, standing nuclear alert, interdicting ethnic cleansing, and maintaining global vigilance, among many other high OPS/PERSTEMPO and fiscally costly missions. Since the demise of the Cold War, the USAF has been asked to do all this, and more, with an ever-dwindling and aging force, and an infrastructure decaying at an unprecedented rate.[26] All of that, coupled with the notion the USAF's two mission technologies, air and space, are the two highest cost military technologies, only adds to the limitations the USAF faces.

With the reasoning for building an effective space force laid out in Part I, and given the limitations just noted, Part II examines the issue of "how" spacepower can be aggressively pursued. After a brief discussion in Chapter Six of the unique historical opportunity the nation finds itself in to advance spacepower, Chapter Seven analyzes required changes in institutional mindsets -- national, Department of Defense (DoD)/joint, as well as USAF. Evolutions in thought are discussed as part of a current USAF effort to institutionalize the aerospace mindset.[27]

Chapter Seven, analyzes organizational options for pursuing spacepower, and discusses the componency of space as a related, but distinct, warfighting media. Included in this discussion are the relations between space and information operations, as well as intelligence. Arguments are made to fundamentally change USAF organizations to realize greater air and space integration, as well as enable mission migration from air to space where and when appropriate and able.

Finally, Chapter Eight examines fiscal issues related to expanding the USAF's aerospace capabilities. Commercial/civil partnerships, launch viability, force structure, readiness versus modernization, and budgeting are all analyzed. In all, Part II attempts to prescribe actions for the USAF to realize its vision of a fully integrated and capable aerospace force.

Conclusion:

The issues are ripe for discussion: a lack of institutional internalization of inherent spacepower advantages, and the internal and external realities impacting spacepower development within the USAF. The intent of analyzing both of these issues is to add to the discussion of spacepower development within the U.S. military in general, and the USAF in particular.

Part I of this thesis is a stepping-stone to a more complete understanding of the utility of spacepower. It is not intended to be a synopsis of a *The Command of Space.*[28] Rather, Part I is intended to demonstrate the advantages of spacepower's development -- that, due to its characteristics, fully capable spacepower provides presence in fundamentally different ways than terrestrial forces do, thereby exerting influence in a more strategically (and politically) flexible manner.

Part II of this thesis is an attempt at offering solutions to many of the external and internal issues affecting the USAF's ability to exploit spacepower. It is not simply a listing of issues. It is an analysis of inputs from many individuals concerned with this important advance in USAF aerospace capabilities. The analyses of both these questions are meant to add to the current discussion about advancing military space capabilities.

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[1] Anecdotally, the author has noted that the strongest proponents of fully capable spacepower are operators who have experience in both components of aerospace power -- air and space. This population includes either aviators who have gained appreciable space experience, or space operators who have gained air experience.
[2] Words of General Michael Ryan, USAF Chief of Staff, from foreword *to Air Force Doctrine Document (AFDD) 2-2, Space Operations*, 23 August 1998.
[3] AFDD 2-2 defines spacepower: "The capability to employ space forces to achieve national security objectives."
[4] *Air Force Global Engagement,* 1995.
[5] SECDEF Report to Congress, Secretary Cohen, 1998.
[6] *Air Force News*, 7 Sep 1999
[7] *Florida Today,* 3 Feb 1999
[8] *Inside the Air Force,* 29 Jan 1999
[9] "The Challenge of Spacepower," A speech before the Fletcher School by Sen. Bob Smith, R-NH, 18 Nov 1998.
[10] Ibid.
[11] *Defense Daily*, 13 Jan 1999
[12] Ibid., 10 Sep 1999
[13] *Air Force Times,* 8 Feb 1999
[14] *Armed Forces Newswire Service.* 23 Nov 1998
[15] In a search of 315 media articles written about military space operations (from 1995 to 1999) its interesting to note that the USAF (or USAF-related agencies) wrote about force enhancement space missions 25% of the time, space control 8%, and space force application 8%. The same survey revealed other services (or their related agencies) wrote about force enhancement 7%, space control 13%, and force application 15%. Non-military entities wrote about force enhancement 8%, space control 13%, and force application 10%. While this survey was not conducted

to answer any deep issues, it does point out that the USAF has been writing less than the other military services, or the non-military mainstream media, about advanced space exploitation issues.

[16] *New World Vistas, Air and Space Power for the 21st Century.* USAF Scientific Advisory Board.

[17] This thesis views spacepower analogous to other forms of national military power -- air, land and sea. No standard definitions seem to exist for any of these terms, however, all seem to have similar characteristics, and hence spacepower can be defined in a similar manner. As Lupton (*On Space Warfare*, Maxwell AFB, 1988, Air University Press) writes:

First, land, sea and air power are elements of national power that enable a nation to exert influence through use of a particular medium. Space power, it follows, is the ability to use the space environment in pursuit of some national objective or purpose. Second, this purpose may NOT be purely military, such as earth resource data collection or civilian communications. Third, all four elements of national power embody not just military forces but civilian capabilities as well. For instance, General H.H. “Hap” Arnold described air power as the total aeronautical capabilities of a nation. Admiral Mahan even included the nature of a country’s political institutions as a determinant of a nation’s sea power. By extension, the space shuttle, a civilian vehicle, along with the political structure that allowed its development, contributes to US space power. A definition that includes these three characteristics is that *space power is the ability of a nation to exploit the space environment in pursuit of national goals and purposes and includes the entire astronautical capabilities of the nation.* (Emphasis in original).

The US is a space power. It has a space infrastructure, both civilian and military, and is presently exploiting space for many purposes. As naval forces supply the military component of sea power, and air forces provide the military component of airpower, so too do space forces supply the military component of spacepower. From this it follows that as terrestrial forces have matured and developed over time, so too will space forces. Hence, the USAF needs to plan for future spacepower capabilities today to make them a reality tomorrow.

[18]The latter analysis is done with an eye toward recent rumblings from Washington calling for a separate space force. To quote an article in the 6 March 2000 issue of *Florida Today*, "On Capital Hill, and at the White House and the Pentagon, the debate is expanding over whether to carve a separate US Space Force that mostly would come out of the US Air Force's hide…what is clear is that a growing number of the nation's leaders are becoming increasingly concerned that the United States could be left vulnerable in future wars--offensively and defensively--if more attention is not paid to space. And some are beginning to believe a separate space force may be the only way to truly protect US security interests…"

[19] Some of the material presented in Part I of this thesis is adapted and modified from the author's 1995 School of Advanced Airpower Studies thesis, "The Inherent Limitations of Spacepower -- Fact or Fiction?"

[20] Colonel Richard Szafranski (USAF, ret), in his insightful paper "GEO, LEO and the Future," makes the point space systems continue to proliferate around the world, and the impact on U.S. national security depends upon how well and how soon other nations understand the potential of space, and upon the degree and purposes to which they exploit the technology. He argues space systems, due to their positional characteristics and technical capabilities, will be used for many missions currently accomplished by terrestrial forces.

[21] This play on terms is a nod toward USAF's "new" concept of targeting for "effect," vice merely targeting airpower-vulnerable target sets. This is nothing new -- merely a repackaging of an old concept. While targeting for effect is essentially the correct thinking, it is more appropriate to target for "results," i.e. choose/engage target sets to elicit the desired response from the adversary.

[22] This thesis demonstrates the ability of spacepower considering a *fully operational and integrated spacepower architecture;* i.e., a force fully capable of accomplishing all four functional applications of military power (support, application, enhancement and control).. That said, as will be demonstrated when inductively analyzing spacepower's ability to influence in Chapter Four, spacepower does not have to be "fully functional" in order to influence an adversary. Today's capabilities, from ISR to space-based target cueing, demonstrate spacepower's ability to "effect" an adversary.

[23] A corollary to this argument adds credence to the requirement for effective space control. As lift becomes cheaper to achieve and technology becomes more readily available, the chances that a “bad actor” will access space is greater. Therefore, the U.S. must have the capability to either restrict these actors’ access or actively defend our resources.

[24]In fact, though national policy currently prohibits fielding certain space force application and space control capabilities, the National and DoD Space Policies both call for the military to investigate development of them.

[25] Throughout this thesis historical analogies, or short dissertations, are used to form some arguments. While direct lines cannot be drawn between the past, present, and future, an understanding of things past can shed light on things future. In this case, an historical analogy can be made with the debate over the B-36, wherein US Navy admirals not only derided the capabilities of modern bomber aviation in general, but also postulated such capabilities may be destabilizing. A more complete discussion of this issue can be found in *Air Force Roles and Missions: A History*, by Warren Trest.

For a recent and cogent discussion of current anti-space warfare thought, see Karl Mueller's two papers presented to the 1999 Annual Meeting of the American Political Science Association, "The Phantom Menace: Assessing Threats to American Interests in Space," and "Space Weapons and U.S. Security: The Dangers of Fortifying the High Frontier." Though well delivered, his argument, like so many others', fails to recognize and acknowledge the historical parallels to those who made similar claims to airpower's ascendance -- that it would be severely destabilizing. In fact, history has proven just the opposite. Additionally, he does not analyze the capabilities of spacepower presented herein -- its ability to asymmetrically influence adversaries and project power.

[26] Lt Gen Roger Dekok, AF/XP, email with author, 20 Oct 1999

[27] The author gratefully acknowledges the information and advice received from Lt Col Darrell Herriges, leader of AF/XP's Aerospace Integration Task Force (AITF)

[28] Published in 1921, but based on the author's ideas as an artillery officer as far back as 1909, Giulio Douhet's *The Command of the Air* remains a visceral work for serious study by theorists, strategists and practitioners of airpower. Though his theories were articulated prior to the realization of technologies that would have made his targeting concepts feasible, his ideas have permeated through to modern times and some airpower practitioners continue to believe in Douhet's propositions. Similar to attempts today to discuss politically charged issues like spacepower, Douhet's views on airpower met staunch political and organizational resistance.

PART I: Why Should Spacepower be Pursued?

Contemporary critics of spacepower have too little sense of history.
Whatever wonders "the stars" hold for our future, there is a vastly nearer-term strategic logic of spacepower that is all but entirely comprehensible in principle today
-- Dr. Colin Gray

Chapter Two

Background Issues

The air war of yesterday becomes the space war of tomorrow.
-- 1960 Democratic Party Policy Statement

...almost any development in the civilian sector that had applicability to warfighting was eventually applied to warfighting...
-- Senator Joseph Lieberman, SASC Hearing on DoD FY01 Budget

Control of space means control of the world, far more certainly, far more totally than any control that has been achieved by weapons or troops of occupation. Space is the ultimate position, the position of total control over Earth.
-- Lyndon Baines Johnson

Now the competition will be for the possession of the unhampered right to traverse and control the most vast, the most important, and the farthest reaching element on the earth, the air, the atmosphere that surrounds us all, that we breathe, live by, and which permeates everything. ... A new set of rules for the conduct of war will have to be devised and a whole new set of ideas of strategy learned by those charged with the conduct of war.
-- Brigadier General William "Billy" Mitchell[1]

Overview

This chapter lays the historical and physical groundwork for the analysis of why spacepower should be pursued. It begins with a discussion of the origins of the term "aerospace," and continues by comparing the mediums of air and space *vis-à-vis* physical differences and "effects" similarities. This is critical to further analysis of the USAF's role in making more advanced and capable spacepower a reality.

Just as critical is public perception. As we live in a democracy, and the public plays the pivotal role on what military capabilities are ultimately fielded, educating the public is important. Therefore, this chapter looks at the historical perspective of military aviation's public education campaign, and discusses implications for spacepower.

Additionally, the chapter reviews airpower's operational, technical, and organizational developments and relates them to spacepower. This review is not included as purely a historical discussion. It demonstrates that airpower, like the potential for spacepower, owed its rapid rise as a dominating form of warfare to its unique ability to affect adversaries in ways previously unimaginable.

Finally, spacepower's development is analyzed in terms of all warfighting mediums. The implications for spacepower are discussed throughout this chapter, and are fine lead-ins to the presentation of military power characteristics in the next chapter.

The "Aerospace" Concept

Though the subject of space was generally considered merely "amusing" in the immediate post-World War II years, the Navy and newly formed USAF were seriously studying "earth satellite vehicles."[2] In fact, fledgling RAND's first-ever study emphasized the viability of reconnaissance satellites. Aside from that, however, there seemed little interest within the USAF for space operations. The post-war drawdown in both personnel and money meant the USAF had little interest or ability to do much with space.

USAF interest in satellites picked up in the early 1950s as the long-range ballistic missile program was reinstituted. RAND continued to study military feasibility of satellites, and in 1956, the USAF issued a requirement for the first reconnaissance satellite, the WS-117L. As Futrell says, "other factors were involved, but the need to establish military worth was significant cause for the nearly 10 year lapse between first conception and initiation of research and development on satellite reconnaissance space systems."[3]

The development of the ICBM and satellites went hand-in-glove. ICBMs gave the USAF the ability to place satellites into operationally significant orbits. In fact, the man who would initially coin the term "aerospace" conceived that "missiles are but one step in the evolution from manned high-performance aircraft to true manned spacecraft; and in the forces structure of the future…we will have all three systems."[4]

On 4 October 1957, the first *Sputnik* was launched and changes began to occur more rapidly within the military. The crisis atmosphere that accompanied Sputnik produced deep and wide-ranging changes to the way the military approached space.[5] The USAF began to view space not as a "strategic backwater"[6] but as a pathway to greater prestige and fiscal authority. Of course, the public feelings of post-*Sputnik* vulnerability helped fuel the military space rush tremendously.

Amid all this turmoil, the Eisenhower administration seemed confused and alternated their policies between their "space for peaceful purposes" approach to more aggressive posturing. For example, the Administration admonished the USAF for thinking outside of the box in a post-*Sputnik* briefing on USAF satellite programs, while at the same time directing that ICBM, IRBM and WS-117L programs "be given the highest and equal national priorities:"

> "Mr. Quarles (DEPSECDEF) took very strong and specific exception to the inclusion in the presentation of any thoughts on the use of a satellite as a weapons carrier and stated the Air Force was out of line in advancing this as a possible application of the satellite. He verbally directed that any such applications not be considered in future Air Force planning. Although General Lemay voiced objections to this on the grounds that we had no assurance that the USSR would not explore this potential and could not be expected to do so, Mr. Quarles remained adamant."[7]

It was in this atmosphere that USAF Chief of Staff General Thomas D. White in a speech to the National Press Club on 29 November 1957 proclaimed space for the United States Air Force. Two major ideas from his speech held great import for the USAF's future.

He laid the conceptual framework for space as the new high ground when he said, "whoever has the capability to control the air is in a position to exert control over the land and seas…whoever has the capability to control space will likewise possess the capability to exert control of the earth...we must win the capability to control space."[8] Using the oft-discussed concept of air superiority, he tied space control to national security, making it a USAF imperative.

General White's second seminal idea led to a major dictum in USAF "aerospace" doctrine when he said, "there is no division, *per se*, between air and space. Air and space are indivisible fields of operations."[9] Said in various ways -- air and space force, air/space force, space and air force -- this concept is today's USAF Holy Grail. The problem, of course, is how to make it reality. Section II of this paper will attempt to help answer that question.

<u>The Air and Space of Aerospace: Physical Differences and Similarities of Effects</u>

In the aggregate, space is simply another environment for conflict. In a strategic sense, it is no different from the land, sea, air, sub-surface, or electromagnetic spectrum. As part of the aerospace equation, however, it varies in physical characteristics with its vertical partner, the air, while maintaining similar effects capabilities.

Physical Differences

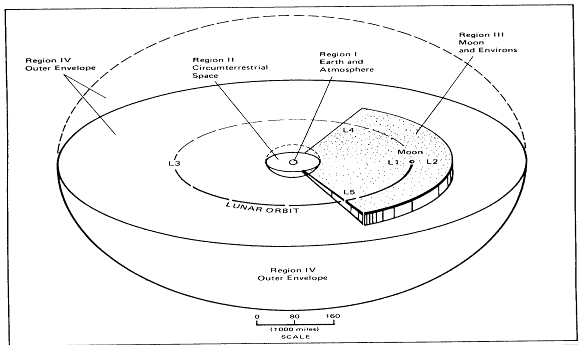
Physically, though their boundary is not well defined, air and space are two completely different mediums. Aerodynamics rule in the air, while orbital dynamics rule in space; the mediums' physical differences being the constituency of air molecules and a near to total vacuum, respectively. While the physics of thermodynamics apply to the warfighting media of land, sea, and air, the physics of space is quite another dimension -- orbital dynamics.

While the physical properties of "air" are well understood by most, since one breathes and lives in it, the properties of "space" are not. Therefore, a short discussion on what constitutes “space” provides a better understanding of the environs within which the ideas in this thesis pertain (figure one). Many sources describe the medium referred to as “space.”[10] However John Collins’ work *Military Space Forces: The Next Fifty Years*, discusses it in simple terms:

> The Earth-Moon System circumscribes four discrete regions: Earth and Atmosphere; Circumterrestrial Space; Moon and Environs; and Outer Envelope. Boundaries are blurred and some attributes overlap, but each nevertheless is individualistic. ... Circumterrestrial space, as defined here, begins about 60 miles above Earth, where aerodynamic drag and frictional heat lose most of their significance (see figure one). The arbitrary upper limit is 50,000 miles.[11]

From an operational standpoint, the high ground of space holds inherent energy advantages over terrestrial media. As in air combat, the use of "God's G," or converting from a position of relative energy advantage due to high potential energy positioning (high to low), is also applicable to space operations (figure two). Military space forces operating from "low" potential energy states in low or near earth orbit, are disadvantaged from those operating farther away -- "at the top of the 'gravity well.'" They also experience less maneuvering room and less reaction time. Whereas gravity hinders earth to space transit, it helps space to earth flight -- and determines strategic placement of space-based assets. "Put simply, it takes less energy to drop objects down a well than to cast them out."[12]

Obviously, space is a unique operating environment for military forces. Although submariners operate in a seemingly unique environment, they retain standard terrestrial realities as direction and geo-position. Similarly, air forces operate in their own medium, but they too retain many similarities to their sister terrestrial forces, such as direction, geo-position, and constant physical affects of operating within the atmosphere. Thus, because space forces operate in a unique medium, they too require operators who completely understand the relative physics.



Distance in miles			
From Earth		From Moon	
Region I	Surface to 60	L1	45,000
II	60 to 50,000	L2	42,000
III	50,000 to 360,000	L3	480,000
IV	240,000 to 480,000	L4	60° ahead of moon
Lunar Orbit	240,000	L5	60° behind moon

NOTE: Regions I, II, and IV are globe-shaped. Region III is like a quarter slice of pie, with little depth in comparison. L1 through L5 are lunar libration points.

Figure One: Space Regions and Environs[13]

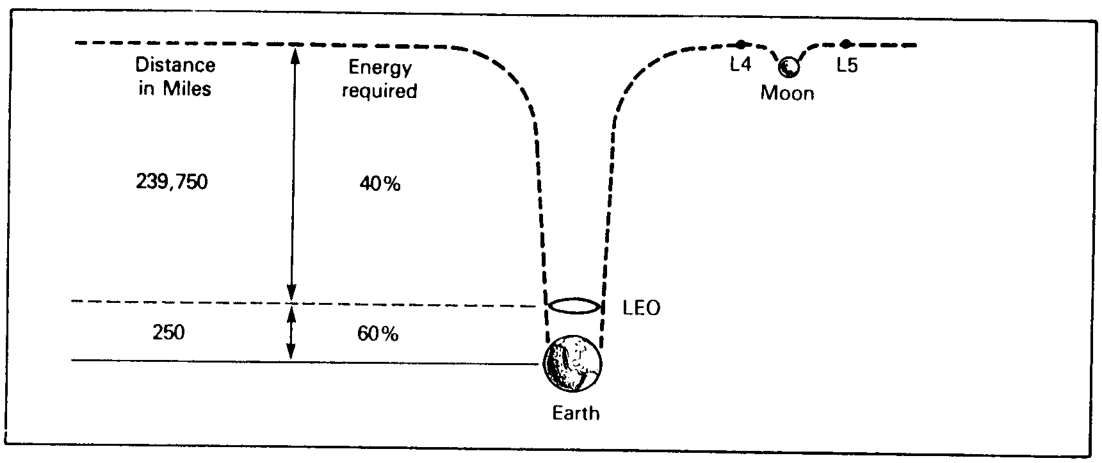


Figure Two: Earth and Moon Gravity Wells[14]

"Effects" Similarities

Though the physics of operating in the media of air and space are distinct, the "effects" to be attained are similar. Like the effects airpower brings to the fight, spacepower allows forces to operate from a position of energy and observational advantage, move rapidly without regard to physical geographical boundaries, and (potentially) apply precise force deep within an enemy's homeland with rapidity and surprise.

Regarding speed, airpower can "effect" the adversary within hours anywhere in the world. Spacepower enjoys a similarly advantageous capability. It can do so either near real-time, in the case of geosynchronous satellites, or within tens of minutes in the case of low earth orbiting satellites. Given advancing technology like the military spaceplane (MSP) and Space Maneuver Vehicle (SMV)[15], adversaries on the opposite side of the globe could be "effected" within minutes. General John Jumper, Commander of Air Combat Command (ACC), "hit" on this unique ability when in his ACC Change of Command speech said, "We will continue to fight to improve combat capability…it's the 'rapid' part [of the Aerospace Expeditionary Force concept] that makes us valuable to our nation."

Regarding access, while airpower enjoys relative freedom of access in relation to the other forms of terrestrial military powers, spacepower is even less encumbered. On-orbit space assets are not limited by national sovereignty. Overflight is not a problem.

Regarding surprise, airpower and spacepower both enjoy a modicum of "stealthiness" when it comes to approaching an adversary. That said, even a somewhat technologically equipped adversary limits both. However, any adversary capability to detect oncoming air or space assets is mitigated by the speed at which these assets can be upon him -- and the altitude at which they operate.

Regarding perspective, both enjoy the situational awareness, and targeting opportunities, associated with their vertical vantage points. Obviously, the higher the asset, the more perspective it has (though optics limit resolution with gains in altitude).

Therefore, though the physics of the mediums are different, the effects of air and space power are similar. Thus the most forceful reason for the USAF being the nation's aerospace force -- the effects gained from the mediums that comprise the realm of aerospace are operationally similar.

That said, airpower is limited in many of the same ways as ground forces and naval forces because of its terrestrial zone of operations[16]. Due to elevation, airpower can rapidly mass large quantities of power anywhere in the world, treaty limitations not withstanding. It can attack strategic targets which surface forces cannot. However, it remains terrestrially limited, as compared to spacepower, by footprint size, geopolitical concerns, and persistence. Another observer has noted: "In addition, just like surface forces, political restrictions could determine where aircraft flew, when, and for what purpose."[17] These concepts will be analyzed further in Chapter Three.

Public Education

Airpower's forefathers, from Douhet in Italy to Mitchell in the U.S., all risked career and livelihood in trying to advance airpower within their respective militaries. In fact, both Douhet and Mitchell were court martialed for their brash attempts to do so. Hence, both took their ideas and issues to the constituency that, in the end, is the most important -- their populations. After all, it was the tax dollars of their citizens that would pay for their concepts. It was their populations' sons and daughters, they promised, who would reap the benefits of war from the air by never again experiencing the horrifics of trench warfare (a la World War I).

Airpower was lucky. Its forefathers had a definitive threat upon which to frame their argument. Additionally, airplanes had been flying for some time and were held in a certain sense of wonderment by those who gathered to witness barnstorming and other aviation feats. Americans intuitively understood airpower's basic operational intricacies.

Conversely, Americans are not aware of any threats to their spacepower.[18] There have been no conflicts yet in which an adversary of the U.S. has negated U.S. space capabilities. U.S. troops have not died due to the U.S. losing control of space -- not yet. Additionally, though spacecraft have been "flying" since 1957, the public has never internalized their operational potential. Though trips to the National Air and Space Museum are popular, the essence of space flight is lost on most of the American public.

Though the US population is not aware of potential threats in space, and though they are not inherently knowledgeable about space operations, they are highly sensitized to effective military capability and the idea of protecting their sons and daughters who their political leaders choose to send into harm's way. In short, they can be "sold" on the fact that spacepower brings most of the aforementioned capabilities of airpower to the fight, as well as some of what sea and land powers bring -- and exponentially better, farther, faster, more often, longer lasting, with shorter logistics tails, and less political baggage. All that, without putting their offspring into harm's way for extended periods of time, or requiring various national political concessions to maintain coalitions, forward base troops and equipment, or allow overflight and seaway. In the end, spacepower must be sold on the fact it can potentially allow US' international conflicts to be decided cheaper -- in loss of life, national treasure, as well as national prestige.

To get this done, spacepower can borrow a page from the epitome of airpower's public consciousness, Alexander P. de Seversky. He was a flying hero of World War I, aircraft designer, stunt pilot, writer and theorist and was airpower's most ardent popularizer for over 30 years.[19] His writings had three main traits that advanced the case for airpower. First, they took on the dogmatic beliefs of military leadership. Second, they were generally directed toward the American people at large, thereby not being subject to various institutional biases. Lastly, his writings maintained his rock-solid belief in the efficacy of airpower's ability to definitively win the nation's wars.

The public must be educated on the possibilities of spacepower. Fortunately, this is beginning to happen, if ever so slowly. Popular, general-population periodicals like *U.S. News and World Reports (USN&WR)*, and *Popular Mechanics*, as well as others, have all recently written pieces on space warfare. In fact, the 8 November 1999 issue of USN&WR had a cover story on "Space Wars: A New Breed of Satellites is Turning the Heavens into the Battlefield of the Future." In that article, various claims were made. Important among them -- from a public education perspective -- were these:

> …that means developing lasers or kinetic energy rods or other weapons that could be used to attack enemy spacecraft or missiles or even ground targets like bridges and buildings. A space-based military force "could deliver precisely calibrated effects, from taking a picture to dropping a precision munition, anywhere on Earth, in less than an hour from the 'go' order, with surprise and immunity to most defenses," according to a 1998 study by the Air Force's scientific advisory board.[20]
>
> In one war game last year, the Air Force tested three types of forces -- one armed mainly with space weapons and two more conventionally equipped -- against the same enemy. The space force won the war in days, while the other outfits took months and required three times as many troops.[21]

Airpower and Spacepower Evolutions

With the need for public education on spacepower similar to the early needs of airpower just discussed as a backdrop, this paper now looks at other similarities that exist between airpower's development and spacepower. Some are cursory, while others are more concrete. Cursory similarities include the difficult conceptual thought required in both cases to develop theories exploiting the military potential of fundamentally new and environmentally hostile mediums, the requirement for a technological knowledge base of current and future developments, and the need for a doctrinal push by military organizations to claim the developmental "turf" of a new medium. More concrete similarities include the way in which each power's resources were first operationally employed, the evolution and relationship of each power's technologies to new roles, and the organizational development of each power within the military. Each one of these concrete similarities is discussed below.[22]

Operational Evolutions and Their Relationships to Military Potential

Peter Hays states "the first military use of these two new mediums was for observation and reconnaissance."[23] This statement is not completely accurate. In actuality, in 1911-12, prior to World War I, the Italians used almost every form of airpower known today against the Turks in Libya. Lee Kennett, in his book *The First Air War, 1914 -1918,* suggests that it was this experience that caused a young Italian artillery officer, named Giulio Douhet, to remark, "A new weapon has come forth, the sky has become a new battlefield." Force application, as well as other air missions, played an advancing role in World War I.

That said, it is generally accepted that the overwhelming bulk of sorties flown by any side in World War I involved aircraft and airships in tactical observation and reconnaissance roles. Likewise, Operation Desert Storm (as well as recent operations in Kosovo), fought seventy-seven years later, utilized military space assets in much the same way. Desert Storm has been called "The First Space War," harking to World War I's appellation, "The First Air War."[24]/[25]

Though other missions were accomplished by airpower in World War I, such as air superiority, strategic bombing, maritime operations and tactical attack, the Great War gave airpower its first large scale opportunity to contribute, mostly by observing for artillery placement and reconnaissance of enemy troop movements and dispositions. Kennett emphasizes this point by illustrating airpower's contributions and technical development from both sides, including German airpower's value at the Battle of Tannenberg and Allied airpower's efforts at the Battle of the Marne. Specifically, he discusses airpower's support of earth-bound forces via communications, positioning, and intelligence and surveillance.

In the early stages of the Great War, as the Germans moved swiftly across the European continent, German observation planes were found most compatible with this rapid movement. From August 15 until September 9, 1914, the *Fliegerabteilung* of the German Third Army Corps changed airfields eighteen times and during that time was grounded by bad weather only two days.[26] Airpower became essential to command and control of German forces, giving commanders much better information to determine where their enemies were. Kennett writes: "German observation planes played a significant role in the east, where their reports, coupled with interceptions of Russian radio transmissions, set the stage for the victory at Tannenberg. Field Marshal von Hindenburg acknowledged his debt to the German Air Service: 'Without the airmen no Tannenberg.'"[27]

Like their enemy, French airmen provided valuable information to their superiors concerning the German's rapid movement in early September. The information provided by Allied air reconnaissance assets was invaluable when the Allies met the Germans at the Battle of the Marne. Sir John French of the British Expeditionary Force said of the squadrons, "they have furnished me with the most complete and accurate information which has been of incalculable value in the conduct of operations."[28] Conversely, the Germans felt the sting of being without a capability to reconnoiter from the air at Marne. The German Second Reserve Corps had no *Fliegerabteilung* of its own, but had to rely on the airplanes of the neighboring Fourth Army Corps. These failed to reconnoiter adequately to the west, precisely where the French Sixth Army was moving to the attack.[29]

Advances in communications via the airplane were great during the War. Dropping of notes attached to rocks to inform commanders of fleeting information was the early primary means -- and was seen as adequate, especially when compared with horse cavalry patrols. Note dropping gave way rapidly to new technology with the introduction of the wireless to the airplane.

In all, positioning of friendly (for navigation and tactical purposes) and enemy forces (for targeting purposes) became exceedingly more precise with the advent of the balloon, and then the airplane. Not only did aircrews directly report positions of friendly and enemy troops, but balloons, which were in use for observation purposes, were used by fixed-wing aviators, and ground troops, to determine their position relative to friendly lines.

Though, as previously discussed, airpower played other significant roles in the Great War, intelligence and surveillance were generally regarded as its *raison d'être.* Altitude, and the capability to travel well behind enemy lines, gave airmen the unique capability to see and determine things never before available to opposing forces. Information on force movements, troop dispositions, deployed weaponry, and enemy re-supply capabilities all became available to the commander who was lucky enough to be supported by air machines. In short, the visibility due to the "fog of war" became a bit better with the introduction of airpower.

Compare the aforementioned synopsis of early airpower's part in World War I to early spacepower's part in Operation Desert Storm and Kosovo. While its true spacepower in the Gulf and Kosovo did not contribute to all four mission areas as airpower did in the Great War, as with airpower in World War I, the Gulf War and Kosovo provided spacepower with its first large scale opportunities to demonstrate its capabilities. Similarly, these capabilities were generally limited to reconnaissance and other command and control-enhancing operations. If used effectively, spacepower severely reduced the "fog of war" for supported commanders, while increasing the opportunity for "fog" to cloud the enemy's decision making.[30] As the Great War proved the efficacy of airpower as a valuable tool for future conflict, the Gulf War and Kosovo seem to have proved the efficacy of spacepower as a viable arm of future military operations.[31]

Like airpower generally in World War I, Allied space assets in the Gulf and Kosovo were limited to functions that supported the other military arms. In today's terms, spacepower's main focus in the Gulf and Kosovo was direct support to warfighting. This mission is termed "force enhancement," and is the main space mission of today's USAF—space as support to terrestrial forces.

Force enhancement includes spacepower capabilities that "provide effective operational support to military forces."[32] As airpower multiplied the combat effectiveness of surface-bound forces in World War I, so too did spacepower multiply the combat effectiveness of terrestrial weapon systems in the Gulf and Kosovo. In fact, a comparison of each powers' early functions demonstrates the similarities. Specifically, in the Gulf, force enhancement capabilities included *communications, navigation and positioning,* and *intelligence and surveillance.*

Space-based communications in Desert Shield/Storm was accomplished via the Defense Satellite Communications System (DSCS) fleet of spacecraft. The system provided a high data rate, high capacity, worldwide, secure voice communications system for command and control, crises management, and intelligence data transmission between the field units, theater command structure and the National Command Authority (NCA). As well as supplying direct communications links, DSCS also provided a bridge for terrestrial communications systems with line-of-sight restrictions across the vast expanses of desert. DSCS provided real time communications between land, air and sea units, as well as television into and out of theater. As the military communication systems became saturated, a sort-of "space-CRAF" (Civil Reserve Air Fleet) idea was adopted to use commercial communications satellites to relay non-secure and non-priority traffic. Coordination for space-based communication support was circuitous, flowing between various J-6 staffs, DISA, as well as other agencies.

The NAVSTAR Global Positioning System (GPS) fleet of satellites carried out navigation and positioning efforts in the Gulf. This system provided Coalition forces precise three-dimensional location and time information. The featureless desert terrain posed significant navigational challenges, thereby increasing the benefit of GPS. Additionally, many targeting systems on US weapons systems (of all services) interfaced with GPS for highly accurate initial, mid-course and terminal guidance. Its popularity became so widespread that aircrews flying Vietnam-era systems, which used notoriously untrustworthy analog inertial navigation systems, bought personal, hand-held GPS receivers to augment their on-board systems. Parents of some infantry personnel included GPS receivers in their children's "CARE" packages. At the outbreak of Desert Shield, the NAVSTAR system had not yet reached full operational capability, but it soon became integral to the Coalition effort. GPS is now an integral capability in new weapon systems and other military equipment.

The US fleet of spy satellites, whose name(s), configuration(s) and specific characteristic(s) are classified, accomplished surveillance in the Gulf. Civil and commercial satellites, such as the French SPOT, used for earth observation, were pressed into service to provide additional surveillance for the Coalition. A widely publicized, key capability of US surveillance satellites is multi-spectral sensing. Satellites over the Gulf provided US commanders and decision makers with optical, radar, and infrared (IR), high-resolution images. Other capabilities included electronics intelligence gathering, or ELINT, though this capability was not as valuable once the war began since Iraqi command and control capability was rapidly degraded early in the conflict. High quality and rapid Battle Damage Assessment (BDA) was another significant advance credited to space systems. Unit complaints about untimely BDA can be attributed to human errors in developing an inefficient and ineffective system vice technical inadequacies in space systems, though certain space force overclassification problems did also, and still do, exist. The highly accurate photo and radar images provided by space platforms allowed for intricate interpretation of damage caused by Coalition “smart bombs.”

Surveillance assets were also used to assist in targeting Iraqi SCUD missile launches. The Defense Support Program (DSP) fleet of spacecraft provided this capability. These satellites sat in their geostationary orbits, constantly looking for telltale SCUD IR plumes. Once observed, the system relayed the location, time and trajectory to USSPACECOM operations crews, who then evaluated and assessed the data before relaying, via the DSCS, to Patriot missile crews in Saudi Arabia, Israel or Turkey. USSPACECOM relay procedures had been practiced for years in accordance with Cold War plans, however the short time factor involved in SCUD launches (roughly seven minutes from launch to impact) forced USSPACECOM to modify relay procedures. New warning alert communications paths were established, refined and exercised. Though United States Central Command (USCENTCOM) had ballistic missile warning information available in early August, the procedures developed between USSPACECOM and USCENTCOM crews during Desert Shield probably paid off in saved lives and resources during Desert Storm. Interestingly, the nation’s “aerospace force” does not own any space-based surveillance assets.

Similar support was rendered by space forces in the Kosovo campaign. There were also some "firsts" for spacepower.

Space assets provided -- for the first time -- real time information into the cockpits of combat aircraft. Pioneered at the Space Warfare Center's Aerospace Integration Facility (which is located at Nellis AFB, Nevada, under the auspices of the Air Warfare Center) this technique and its associated equipment has become known as RTIC, or "real time information to the cockpit." B-1s and B-52s were equipped to receive the latest intelligence and tactical information overlaid onto imagery.

Another space support first in Kosovo was the use of DSP satellites for battle strike indications. Via close coordination between the Combined Air Operations Center in Vincenza, Italy, and the 11th Space Warning Squadron at Schriever AFB, Colorado, flight routing, timing, and targeting information was compared with satellite infrared data to determine strike indications.

An important facet of all of this space support was that it was accomplished in the Gulf and in Kosovo with very few space operators deployed to theater. High-impact, small footprint operations are today's space support hallmark -- and the political promise for tomorrow's fully capable space forces.

Technical Evolutions and Their Relationships to Military Potential

With this comparison of airpower's and spacepower's operational evolutions complete, what follows is a comparison of airpower's and spacepower's technological evolutions. As airpower developed rapidly from a technological standpoint, so too did its military potential. Within the span of just a few years, airpower evolved from a generally supportive military role to a direct offensive role. Spacepower is now advancing technologically in a very rapid manner. There seems no reason to assume that spacepower cannot, technologically, mimic airpower's offensive evolution.

That said, caution is advised. The most powerful early doctrines developed for both airpower and spacepower emphasized the war-winning potential of strategic applications of force from these new combat mediums.[33] However, as spacepower develops, care must be taken to not fall into early airpower's doctrinal trap of promising too much, too soon.

As airpower advanced technologically after World War I, its primary function became strategic bombardment. Giulio Douhet, impressed by airpower's capabilities and potential he witnessed in the Great War, drafted his offensive airpower theory in *The Command of the Air.* Other great airpower thinkers followed, General William "Billy" Mitchell, Alexander de Seversky, Air Vice Marshal Hugh Trenchard, and General James "Jimmy" Doolittle to name a few. All focused on the offensive capabilities of airpower. Douhet describes the offensive nature of airpower in this way:

> there is no practical way to prevent the enemy from attacking us with his air force except to destroy his air power before he has a chance to strike at us. It is now axiomatic -- and has long been so -- that coastlines are defended from naval attacks, not by dispersing guns and ships along their whole extent, but by conquering the command of the seas; that is, by preventing the enemy from navigating. The surface of the earth is the coastline of the air. The conditions pertaining to both elements, the air and the sea, are analogous; so that the surface of the earth, both solid and liquid, should be defended from aerial attack, not by scattering guns and planes over its whole extent, but by preventing the enemy from flying. In other words, by "conquering the command of the air."[34]

Douhet continued later in his work, " [an air force's] sole concern should be to do the enemy the greatest possible amount of surface damage in the shortest possible time, ..."[35]

By the end of World War I, technology allowed airpower to be used separately from surface forces, though not very effectively, to bomb well beyond the battlefront in efforts to affect the enemy infrastructure and its ability to wage war. Government centers, industry, and transportation links were now targetable by air, though such targets were not at great risk due to the technology of the day. This would change over time. An analogy to this situation can be drawn with today's evolutionary period of spacepower.

Mission Area	*Function*	*Program*
Enhancement	Navigation	- TRANSIT - GPS - GLONASS
	Weather	- TIROS - DMSP
	Communication	- COURIER ACTIVE - DSCS - MILSTAR - IRIDIUM - TELEDESIC - GEOSYNC
	Earth Resources	- SPOT - LANDSAT - JERS - ERS - FSW - GREEN SAT
	Surveillance and Recce	- Classified Assets - Discoverer II - TACSATS (ELINT/IMINT)
Support	Lift and Maintainability	- Unconventional Space Lift - SSTO - MSP/SOV/SMV - TAV - Micro-SATs - Cryogenic Fuels - HYFLEX
Control	Missile Detection and Space Defense	- MIDAS - Satellite Inspector - ROBO/Dyna-Soar - Multisensory Tracking - ASAT - SBIRS (High and Low) - Decoy and Deceive Technologies
Force Application	Kinetic Energy Kill	- Advanced Maneuvering Reentry Vehicles - Tactical Reentry Impacting Munition (TRIM) - Impact Technology Program (ITP) - Discriminating Attack Capability (DAC) - Defense Suppression Vehicle - Common Aero Vehicle (CAV) - Global Prompt Response Capability (GPRC)
	High Explosive Kill	- Sandia Winged Energetic Reentry Vehicle Experimental (SWERVE) - Hypersonic Glide Vehicle (HGV)
	Directed Energy Kill	- Beam Experiments Aboard Rocket (BEAR) - Space Based Laser (SBL)

Figure One: Spacepower Technologies[36]

Technologically, spacepower can get there today, but it is limited in what it can do offensively. A thorough review of the USAF Scientific Advisory Board's *New World Vistas* suggests this, too, most likely will change over time: "Future space systems will be well suited to project force against air, land and sea based targets anywhere on earth. Precise delivery of munitions, directed energy or electronic warfare on virtually any target, heavily defended or not, within minutes or hours of tasking and with minimal risk to US forces could have a decisive impact at all levels of conflict."[37]

Table one illustrates that space forces capable of carrying out all four functional mission areas currently accomplished by terrestrial forces are theoretically possible today. Obviously, not all of these capabilities are presently fielded, nor were all of them deemed operationally feasible. That said, the technology most experts consider the primary enabler for complete spacepower exploitation -- MSP/SOV/SMV -- is well underway (a fairly complete discussion of this technology is included as Appendix One to this thesis)[38] The catalysts are national will and funding. Both are analyzed later in this paper.[39]

Organizational Evolutions and Their Relationships to Military Potential:

Part and parcel to the technological development of airpower was its organizational development. Many writers advance the idea that it was actually the wish to identify a need for independent air forces that spawned offensive airpower theories. Due to airpower's evolution during the interwar years, incremental organizational changes took place. In the US, the changes led from the Air Service to the Air Corps to the Army Air Forces and finally to the independent Air Force. Hays states that the emergence of Air Force Space Command (AFSPACECOM) and USSPACECOM may be similar organizational steps towards the eventual creation of an independent space force.[40]

Douhet, Mitchell and other airpower thinkers pushed for establishment of separate air forces due to their perceptions that airpower proved a decisive form of warfare. Strategic bombardment became the backbone of the air mission. This legacy is apparent in Air Force Manual 1-1, as it contrasts surface forces to "aerospace power" that "can be the decisive force in warfare."[41] The manual lists and describes all of the missions the USAF is responsible for. The largest mission, and the one at the beginning of the list, is:

> Strategic Aerospace Offense objectives are to neutralize or destroy an enemy's war-sustaining capabilities or will to fight. Aerospace forces may conduct strategic aerospace offense actions, at all levels of conflict, through the systematic application of force to a selected series of vital targets. Attacks are directed against an enemy's key military, political, and economic power base. Strategic aerospace offense targets may include: concentrations of uncommitted elements of enemy armed forces, strategic weapon systems, command centers, communications facilities, manufacturing systems, sources of raw material, critical material stockpiles, power systems, transportation systems, and key agricultural areas. Strategic aerospace offense may involve projection of power, with limited or massive application of force, or merely positioning of force as a threat to achieve a desired objective.[42]

It seems with all of the attention paid to strategic attack as the *raison d'être* of the USAF, the removal of this mission might signal a certain lack of legitimacy in the institution. The Air Force would become nothing more than a support arm for the surface forces, providing air superiority over the battlespace, close air support, local reconnaissance, and resupply missions. The debate would then hark back to the arguments of the early forties. Why have a separate air force if airpower is purely a support function for the surface forces?

This hypothetical situation is somewhat analogous to today's space operations.[43] As mentioned earlier, space forces exist today to support terrestrial forces. However, the realization of space force application (akin to strategic aerial bombardment) and space control (akin to air superiority) capabilities, like airpower's development, will present spacepower with its own *raison d'être*, thereby making the establishment of a separate space force a possibility. *Though* *the thrust of this paper is that such capabilities are best employed by the USAF, it seems this possibility is increased if the USAF is either unwilling (due to internal influences, biases and internal constraints) or unable (due to external influences) to completely integrate spacepower into its own operations and migrate its missions to space where and when appropriate.*

Spacepower Evolution in Terms of All Warfighting Mediums' Evolutions:

Sun Tzu based his writings on years of Chinese ground combat experience. Clausewitz and Jomini had the same luxury upon which to base their thoughts and ideas. Every ground power theorist since has based his argument on millenniums of ground warfare experience. To a certain extent, the same holds true for naval war theory. Many years of historical experience existed before Mahan, and then Corbett, wrote their masterpieces. Even Thucydides wrote of naval battles in the Peloponnesian Wars of the 5th Century BC. This long history has formed the basis of modern ground power and naval theories.

In contrast, early airpower theorists, like Douhet and Mitchell, had relatively limited experience to draw upon as they developed their theories. However, airpower had attempted all of its present mission forms prior to Douhet's writing. Airpower had demonstrated force application, force enhancement, support and control with varying degrees of success in the 1911 Libyan conflict between Turkey and Italy. Though their ideas may have been sparked by this limited experience, Douhet's and Mitchell's theories *extrapolated greater abilities than existed in their day.*

Unlike ground and naval theorists, airpower theorists seemed to base their notions not so much on historical experience, but rather on the logical application of present and future concepts. Whereas Clausewitz based much of his writing on Napoleon's successful campaigns and concepts, Douhet and Mitchell had no such *successful* experience upon which to base their theories of strategic attack. In fact, if success were a criterion for using experience in theory, airpower theory would not have been written in Douhet's day. Airpower theories looked to the advent of technologies to realize success.

Spacepower theory is at a similar juncture today. Experience is relatively short lived. At the outside, if one argues that V-2 missions were space force application ventures, spacepower historical experience reaches back fifty years.[44] If one considers the Gulf War the first war involving heavy space utilization, only a decade's experience exists.

Like airpower theory, this thesis looks at present and toward future capabilities. It does not do so without regard to reality. Projects have been carried out since the late 1950s to demonstrate spacepower capabilities, including all four functional mission areas (see figure one). These technologies exist now, are in progress, or have already been studied. More capable spacepower than today's is not a dream, just as more capable airpower was not a dream in Douhet's day. According to some, spacepower today is not limited by technology as much as it is by political will and funding.[45] This chapter demonstrates the irony in this situation.

Roots of spacepower thinking in the Air Force go back to Air Corps days and General "Hap" Arnold. Having witnessed the operational reality of the V-1 and V-2, he wrote, "we must be ready to launch such projectiles nearer the target, to give them a shorter time of flight and make them harder to detect and destroy. We must be ready to launch them from unexpected directions. This can be done from true space ships, capable of operating outside the earth's atmosphere."[46] In his 1949 *Air University Review* article, "Blueprints for Space," Brigadier General Homer Boushey, then-Director of Advanced Technology, Deputy Chief of Staff, Development, Headquarters USAF, wrote,

> I believe satellite vehicles can prove immensely useful to mankind. Appropriately utilized, they could provide a manned space patrol for peaceful purposes. They can provide attack warning and assist in mutual inspection programs. Another use would be purely military -- bombardment -- and accomplished by space vehicles.[47]

Conclusion

Spacepower seems to be developing somewhat similarly to airpower. Though the media are physically different, the effects realized from space are similar to those realized from the air. Airpower's rapid rise to dominance as a form of warfare was due to the unique advantages that vertical positioning, speed, and eventually range, gave to the warfighter. From their early military uses as observation and reconnaissance platforms, both airpower and spacepower continue to evolve. Airpower gained its present status as a separate, and some would argue dominant, form of warfare through technologically developing its offensive capability. The similarities between airpower's and spacepower's (thus far) developments suggest that spacepower could end up evolving in much the same way.

The remainder of Part I offers a theory of spacepower, highlighting its potential advantages. The following two chapters discuss military characteristics as they apply to spacepower, and how these characteristics give it the capability to project presence, which, in turn, allows it to influence actors. Chapter Five applies these characteristics and capabilities to a model to demonstrate how spacepower's characteristics and capabilities can influence actors.

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[1] Modified by President Johnson's remark preceding it, General Mitchell's argument holds as true today for spacepower as it did in his day (this passage was written in 1925) for airpower.
[2] Robert Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, 1907-1960* (Maxwell AFB, AL: Air University Press, 1989), 541.
[3] Ibid, 541.
[4] House, *DoD Appropriations for 1958*, 122
[5] Peter L.Hays, "Struggling Towards Space Doctrine: US Military Space Plans, Programs and Perspectives During the Cold War," Doctoral thesis presented to Fletcher School of Law and Diplomacy, May 1994.
[6] Hays, 104
[7] Colonel F.C.E. Oder, USAF, Director, WS-117L, Memo for Record, "Briefing of Deputy Secretary of Defense Mr. Quarles on WS-117L on 16 October 1957," 25 October 1957. Quoted in Hays, 114

[8] Eugene M. Emme, ed., The Impact of Air Power: National Security and World Politics, (Princeton: Van Nostrand, 1959), 497
[9] Ibid. 499
[10] For a very interesting treatise on the relationship between the various "regions" of space (vis-à-vis earth) and their effect on geopolitical discourse, see Everett C. Dolman's work "Geostrategy in the Space Age: An Astropolitical Analysis." (*Journal of Strategic Studies*, Essex, Uk, 2000).
[11] John M. Collins. *Military Space Forces: The Next Fifty Years*. (Washington: Pergamon-Brassey's, 1989), 6 - 15. The US Congress commissioned this work to "prepare a frame of reference that could help Congress evaluate future, as well as present, military space policies, programs, and budgets." This work not only describes space, it also discusses strategic options, as well as organizational and force development issues. Collins' analysis of the area of space is in-depth. While discussing useful orbits for today's operations, he also delves into more long-term area considerations. As an example, he discusses the physical anomalies existent in space as related to other warfighting media. There are areas in space at which, theoretically, little or no energy is required to maintain position, and from which energy can be used advantageously to affect near-earth space, as well as earth, itself. These are termed the libration points. Collins writes:

"The five so-called libration points are not points at all, but three-dimensional positions in space. Mathematical models and computer simulations indicate that free-floating objects within their respective spheres of influence tend to remain there, because gravitational fields of Earth and moon are in balance. Spacecraft could theoretically linger for long periods without expending significant fuel.

L1 through L3, on a line with Earth and moon, are considered unstable. Objects at those locations, perturbed by the sun and other forces, will wander farther and farther away, if calculations are correct. L4 and L5, 60 degrees ahead of and behind the moon in its orbit, assertedly are stable. Objects at those locations probably resist drift more vigorously and, if it begins, remain in that general region."

Collins goes on to describe the uniqueness of space vis-à-vis all other warfighting mediums:
"Air, water, weather, climate and vegetation within the Earth-Moon System are exclusively indigenous to this planet. So are populations and industries at present. Land forms and natural resources are restricted to the Earth, moon and asteroids. Cosmic radiation, solar winds, micrometeorites and negligible or neutralized gravity are unique properties of free space. Near vacuum is present everywhere except Earth and vicinity.

Space and oceans are superficially similar, but differences are more remarkable. Continents bound all seven seas, which are liquid and almost opaque. Topographic features configure ocean bottoms. The Earth's curvature limits visibility to line-of-sight; natural light never illuminates deeply. Water temperature, pressure and salinity anomalies are common.

Space has no north, east, south or west. Right ascension and declination, calculated in different terms than latitude and longitude, designate location and directions. A nonrotating celestial sphere of infinite radius, with its center at Earth's core is the reference frame. Declination, the astronomical analog of latitude, is the angular distance north or south of the celestial equator. Right ascension is the astronomical analog of longitude. The constellation Aries, against which spectators on Earth see the sun when it crosses Earth's equator in spring, defines the prime meridian. Angular positions in space are measured east from that celestial counterpart of Greenwich Observatory.

Distances are meaningful mainly in terms of time. Merchant ships en route from our Pacific coast to the Persian Gulf, for example, take a month to travel 12,000 nautical miles. Apollo 11 made it to the moon - 20 times farther - in slightly more than three days."
[12] Ibid., 23.
[13] Ibid., 7.
[14] Ibid., 24.
[15] MSP (or Space Operations Vehicle [SOV]) and SMV technology is well underway (see Air Force Research Lab [AFRL] briefing "MS-1A Military Spaceplane" by Major Ken Verderame. Test vehicles have been flown endoatmospherically and are on timeline. MSP/SOV technology entails a reusable space vehicle capable of operating with various mission loads either into orbit or on short-duration "pop-up" missions. According to AFRL, this technology could be IOC by mid-2011.

SMV technology is basically the same, involving "mini" spaceplanes that deploy from an MSP/SOV and are capable of staying on-orbit to accomplish various missions, or until required to perform a mission requiring de-orbit. Once a SMV's mission is complete, it returns to its operating base for re-tasking. This same briefing notes this technology could be IOC by mid-2010.

[16] Granted, airpower has one great liberating characteristic from the other terrestrial forces--elevation. However, due to atmospheric (drag, gravity, etc.) and geopolitical (overflight restrictions, basing concerns, etc.) limitations it is limited in similar ways as other terrestrial forces.

[17] Phillip Meilinger, Colonel, USAF. "Ten Propositions Regarding Airpower." School of Advanced Airpower Studies, Maxwell AFB, AL. August 1994. p.3

[18] Recent statements out of China are an exception. China has threatened the US with ICBM strikes if the US defends Taiwan in a Taiwan-China conflict, reports the *Washington Times*, 29 February 2000. Unfortunately, because the US has not aggressively pursued space control technologies until very recently, and then only half-heartedly (some would criticize), the US finds itself in the position of having to resort to the Cold War deterrent paradigm to negate the Chinese threat--versus actively being able to negate the threat with a viable space control capability, thereby strengthening its position to actively defend Taiwan.

[19] See Phillip Meilinger's "Alexander P de Seversky and American Airpower" in *The Paths of Heaven: The Evolution of Airpower Thought* (Maxwell AFB, AL, 1997) for an outstanding dissertation on the life and times of this great airpower proponent.

[20] "The New Space Race," *U.S. News and World Report*, 8 November 1999, 37

[21] Ibid, 37

[22] Care must be taken when drawing these analogies to not assume a *direct* correlation between the developments of the two powers. For example, although technology is an obvious vein in both powers' development, the scale, complexity and cost involved in spacepower development are currently far out of proportion to the same variables in airpower's development (though a case will be made in Chapter 9 regarding declining proportional space system costs). Large-scale government investments have been the norm for spacepower's development, e.g. NASA and NRO, while airpower tended to share more developmental funding between government and private sources, e.g. airlines and commercial aircraft makers.

Importantly, this is changing. Though almost exclusive government funding gave spacepower its start, the economic priority inherent to commercial space opportunities suggests increased private funding to advance coming space technologies. An early case-in-point is Microsoft mogul Bill Gates' foray into space launch and satellite systems to expand the information management capabilities of his company. Spacepower's developmental funding flow may turn out, over time, to mirror image airpower's.

[23] In Hays' "Struggling Towards Space Doctrine…," he compares the development of airpower to spacepower in an attempt to determine three critical steps in airpower's development that might explain spacepower's future development.

[24] Sir Peter Anson and Captain Dennis Cummings (RAF). "The First Space War: The Contributions of Satellites to the Gulf War." *RUSI Journal*, (Winter 1991) Vol. 136, No. 4: 45.

[25] Kennett, *The First Air War.* Title page.

[26] Ibid., 31.

[27] Ibid., 31.

[28] Ibid., 32.

[29] Ibid.

[30] Given rapidly advancing technology, this statement could be made even stronger with regard to spacepower contributions to recent Kosovo operations, including information operations as it relates to spacepower.

[31] However, many insist the Gulf War was **not** for spacepower what the Great War was for airpower. This can be argued in three ways. If one considers V-2 attacks in World War II as the first instance of space force application, although the primary use of space assets in the Gulf were reconnaissance and other force enhancement missions, then the Gulf War and spacepower can be equitable compared to World War I and airpower. If one does not consider the V-2 space force application, but realizes the research and development that has been accomplished toward space force application capabilities since 1958, the Gulf War could still be equitably compared to World War I for space and airpower. In the absence of any realization of space force application technology, spacepower in the Gulf is not comparable to airpower in World War I. Rather it would be equated to airpower in the years immediately preceding the Turkish - Italian conflict in Libya, around 1908 - 1909.

[32] *Joint Chiefs of Staff Publication 3-14: Tactics, Techniques and Procedures for Space Operations.* (Washington DC: GPO, 15 April 1992), I-15.

[33] Hays, "Struggling Towards Space Doctrine." 27.

[34] Giulio Douhet. *The Command of the Air.* Translated by Dino Ferrari. (Washington, DC: Office of Air Force History, 1983) 18 - 19.
[35] Ibid., 59.
[36] Due to space force administrative characteristic of classifying many programs, this is a partial list and reflects data from many sources including: Cargill Hall. "The Origins of US Space Policy." *Colloquy: Security Affairs Support Association.* Vol 14, Dec 1993: 5 - 24. Michael A. Durnheim, "DCX Proving Initial Operating Concepts." *Aviation Week and Space Technology*, Mar 8, 1993: 49. Edward H. Kolcum, "Pratt and Whitney Assessing Family of Engines for Upcoming Space Missions." *Aviation Week and Space Technology*, Jan 6, 1992: 56. Philip Bono and Kenneth Gatland, *Frontiers of Space.* (London: Blandford Press, 1969): 199. Major Jess Sponable, "Single Stage Rocket Technology Program Review of Future Systems and Applications." briefing viewgraphs, Ballistic Missile Defense Organization, Jan 1993. "Force Applications Study Final Report." Phillips Laboratory, 1991 (SECRET) (Data used is from unclassified briefing slides). Major Michael Muolo, ed., *Space Handbook: A Warfighter's Guide To Space, Vol 1* (Maxwell AFB, AL: Air University Press, 1993). Richard D. Hudson, Jr., *Infrared System Engineering* (New York: John Wiley and Sons, 1969): 507. "The Strategic Hypersonic Aerospace Campaign." SPACECAST 2020, Maxwell AFB, AL, June 1994. Lt Col Mike Kaufhold, et al. "Reinventing Air Force Space" briefing slides, Space Warfare Center/XRC, Aug 1994.
[37] *New World Vistas*, Space Applications Volume, p. ix.
[38] See footnote above for discussion on AFRL views of MSP/SOV/SMV technology. CAV technology is also maturing. This, coupled with MSP/SOV/SMV, allows near-term space force application to be a reality **(given political direction to conduct such operations).** In fact, Global Engagement 4, the USAF annual wargame conducted in October 1999, employed such technologies. Each of the three CINCs, former USAF, USN and USA flag officers, utilized such assets to their maximum sortie capable rates. A major lesson learned from GE4 was that such space assets will be best employed as regular "bullets" vice "silver bullets."
[39] Recent words of Secretary of Defense (SecDef) William Cohen suggests this may be starting to occur. In his FY01 DoD Budget testimony in front of the Senate Armed Service's Committee (SASC), on 8 February 2000, Cohen said, "…with the advent of technology multiplying at exponential rates of growth, we certainly can achieve breakthroughs in the use of these new technologies for our people." This was in response to a question from the SASC Chairman, Senator Warner, who asked, "Do you feel that we can, in a greater way, harness the technology of this country for the benefit of the men and women in the armed forces and make substantial changes in our procurement in the immediate years and the outyears?" (Transcripts of the SASC Hearing on the FY01 DoD Budget, 8 Feb 2000).
[40] Hays. "Struggling Towards Space Doctrine." 27.
[41] *Air Force Manual 1-1* (1984), 1 - 3.
[42] Ibid., 3 - 2.
[43] Dana Johnson, in her doctoral dissertation at the University of Southern California, entitled "The Evolution of US Military Space Doctrine," presents an analysis of spacepower's developmental similarities and differences to the USAF and the Navy. She discusses the impact of the varying requirements placed on the space force by all of the services and concludes that space is a truly joint arena, and should be managed to support all services to ensure minimum duplication of effort. She points out that space leaders could learn from a study of airpower's and seapower's developments.
[44] The author does not agree with this assumption, however. Though the vehicle transited space, and used its positional advantage, it could not capitalize on spacepower characteristics as noted later in the chapter.
[45] Discussions between the author and various scientists at Kirtland AFB's Phillips Laboratory, April 1995 and August 1999. Mark R. Whittington, "Stifled By Political Correctness." Forces and Capabilities Text, Air War College, Air University, Maxwell AFB, AL, 1995: 28 -29. Baum, Michael E. "Defiling the Altar: The Weaponization of Space." *Airpower Journal* (Spring 1994): 61.
[46] General of the Army H.H. "Hap" Arnold, *The War Reports of Marshall, Arnold and King.* (New York: Lippincott. 1947), 455.
[47] Homer A. Bousher, "Blueprints for Space." *Air University Quarterly Review,* no. 11 (Spring 1959), 18.

Chapter Three

A Comparative Analysis of Differing Characteristics of Military Power

We should on all occasions avoid a general Action, or put anything to Risqué, unless compelled by a necessity, into which we ought never be drawn.
-- George Washington, 1776

These short summaries of the influence of the air arm on the forms of war on land and sea should suffice to make people realize the magnitude of the revolution and the seriousness of the problems which face the armies and navies.
-- Giulio Douhet

[DoD leadership] must do the hard intellectual work necessary to analyze the challenges of the future, the technology we know is coming our way, and the new tactics and procedures that will make us successful on the battlefields of the future.
-- Admiral William Gehman, CINC Joint Forces Command

Overview

Similar to Douhet's approach to comparatively analyzing airpower with the other forms of military power in his day, this chapter discusses the characteristics of spacepower in terms of the other forms of military power — and analyzes them as they relate to employing military force. Characteristics described here include strategic agility, ability to demonstrate commitment and credibility, economic considerations, military considerations, and political considerations.

First, the characteristics are defined and discussed in general in order to bound the argument. A comparison is then made of how these characteristics apply to terrestrial forces as well as space forces as military power is deployed (from garrisoned to engaged). The chapter concludes with a discussion of political flexibility; specifically, how it is enhanced by certain characteristics of military power.

Most readers are familiar with the advantages and disadvantages of all the terrestrial military powers, especially how they interrelate. This discussion goes the next step by interrelating spacepower advantages and disadvantages. This thesis analyzes military force characteristics as they apply to today's terrestrial forces and two variations of today's space forces—those theoretically possible today, and those actually fielded today.[1] The dichotomy between these comparisons illustrates the desirability of future fully functional military space forces.

This analysis is not meant to advocate the use of one form of military power vice another. Obviously, most conflicts are fought jointly. It is almost never appropriate, or militarily advantageous, for one type of military power to be employed singularly. The synthesis of effects gained by jointly employing fires is almost always the proper solution. Each type of a power's particular advantages and disadvantages, given the situation at hand, are weighed when configuring the appropriate force structure to employ. It is the art of the commander to determine what proportion of each type of power is required, as well as when and where it is best employed. Meilinger makes this point when he writes,

> Separateness does not equal singularity. Wars are fought in many ways with many weapons. Seldom is one service used to wage a campaign or war, although one service may be dominant in them. The nature of the enemy and the war, the objectives to be achieved, and the price willing to be paid by the people will determine what military instruments will be employed and in what proportion.[2]

The bottom line is that military forces are compared in various ways, but it is often their political acceptability that determines their usefulness. Unique equipment, operating mediums and doctrinal differences are common parameters for comparison. However, such compartmentalization often results in incomplete comparisons, as distinctions between military forces are often unclear. For example, airpower connotes abilities from multiple military forces, employing various types of equipment, for numerous doctrinal reasons. Therefore, this thesis deals with discriminating between military forces based on *real politik* characteristics. Forces are compared based on perceived political applicability, because at the end of the day, it is the political usefulness of a force, not operational dissimilarities from one another, which is most meaningful.

Characteristics of Military Power

Regardless of the type of military power considered, they all share common characteristics. These characteristics represent a diverse field of considerations necessary to capture the essence of military power. They are diverse, yet interrelated. This relationship reflects the association between military power itself and political will. It is this latter relationship that, in the end, determines the applicability of each form of military power to any given situation.

The characteristics of military power discussed here include strategic agility, ability to demonstrate commitment and credibility, economic considerations, military considerations, and political considerations. How these characteristics apply to forms of military power change as the status of forces changes from being homebased,[3] to deploying into an area, and to engaging in combat. All of these characteristics are essential to determine the political flexibility of applying the military element of power. Basic definitions of each characteristic follow.

Strategic Agility

Strategic agility is the ability to respond rapidly, over global distances, with appropriate capabilities to carry out operations in support of US interests.[4] This concept takes on even greater import as US forces are restructured and decreased, while US global interests and possible trouble spots increase. Various "futures" studies (buttressed by world events since the end of the Cold War) have noted the probability of multiple conflicts, in various stages of resolution, occurring in areas around the world vital to US national interests. Hence, the ability to respond rapidly anywhere in the world with appropriate force is a basic requirement for effective military response, and is therefore in the US national interest.

Commitment/Credibility

The terms commitment and credibility go hand-in-hand. Commitment refers to the state of being bound emotionally, or intellectually, to a course of action or ideal. The dictionary refers to it as a “pledge to act.” Credibility takes this concept another step by making this commitment, or pledge to act, plausible. In other words, what makes the entity the US wishes to influence (or "effect") believe the US will act on a notion of international or national interest?[5] The answer lies in the entity's perception of US capability *and* will to act.

In the past, these terms have been closely identified with the concept of deterrence. Thomas Schelling, in his work *Arms and Influence*, talks at length about what he terms “The Art of Commitment.” He frames his argument in terms of the Cold War, and posits that an adversary must be communicated with effectively in order to realize one’s strategy. If a country has gone to great lengths to influence an adversary, but has not communicated its commitment or credibility to act, then it has failed -- the adversary remains uninfluenced.

Interestingly, in the Cold War paradigm, Schelling suggests that in order to effectively communicate to an adversary its commitment and credibility, the country must physically, or morally, put itself into a situation from which its only rational act would be to act.

> Just saying so won’t do it. What we have to do is to get ourselves into a position where we cannot fail to react as we said we would -- where we just cannot help it -- or where we would be obliged by some overwhelming cost of not reacting in the manner we had declared. Often we must maneuver into a position where we no longer have much choice left. Thus is the old business of burning bridges.”[6]

The paradigm of conventional terrestrial force commitment and credibility has always included the notion of putting forces at risk to make a point. In other words, nothing demonstrated US resolve more than to put our sons and daughters in harm's way. To a certain extent, this remains valid.

However, this thesis suggests an alternative solution -- a unique application of these concepts as applied to an adjunct force. Such a force could demonstrate commitment and credibility for less Machiavellian reasons. If a force were "easy" to use -- economically, militarily, and politically -- it would be engendered with commitment and credibility. The very fact that such force is "easy" to use makes its use more probable -- and therefore credible. The adversary need not consider that US personnel and equipment are at risk to prove credibility and commitment; rather, these concepts would exist by US capability to apply force with decreased regard to risk of any kind. This virtual decreased risk, then, becomes the mechanism to convince adversarial leadership of US ability and willingness to act. This "Third Wave"[7] concept is the antithesis of the Industrial Warfare paradigm of proving commitment and credibility through putting one's forces in harm's way.

Economic Considerations

A discussion of the myriad of issues involved in the fiscal realities of military forces is beyond the scope of this chapter. However, to narrow the focus, the USAF seems to believe the basic economic consideration for military forces is the ability to efficiently allocate resources required to deploy and employ capabilities.[8] Military forces are expensive and, generally, their size and capability demonstrate the vastness, or lack thereof, of a country's treasure and international stature. One need only refer to present day media to discern the immense amount of fiscal resources involved in fielding a credible and able fighting force.

As the US downsizes its military and takes advantage of the "peace dividend," the susceptibility of US forces to physical loss or damage, or increasing expense involved in deployment and operations, weighs heavily into political decision making. When comparing forms of military power by economic considerations, many variables exist. Susceptibility of forces to loss or damage, research and development costs, acquisition costs, operational costs, and associated costs (manning, infrastructure, etc.) are all considerations.

However, when considering the economics of applying military force, one must realize forces are bought and exist for a basic purpose -- as diplomatic tools to provide for national interests. Forces are a vital tool for diplomacy, as well as providing directly for US national security. This fact might mitigate some of the previous arguments. For example, if forces were used in the interest of a close ally, or for operations upon which monumental national economic priorities exist, economic arguments against using such force may be mute. This said, though, if the same effects could be rendered by an adjunct force with fewer risks, regardless of diplomatic or national security priorities, this would seem advantageous.

Military Considerations

This concept is closely associated with economic and political considerations. The susceptibility of a force to degradation, or destruction, is the measure of its military vulnerability. As the USAF defines it, survivability is the key -- the ability to limit risks.[9] For a deployed force, this plays heavily into command planning functions.[10] Obviously, as a military's susceptibility to degradation, or destruction, is increased, so too are associated considerations. Associated considerations include training, replacements, loss rates, family considerations, media relations, unit cohesiveness, and coalition dynamics, to name a few.

Aside from these "negative" aspects, military forces are built and maintained with one mission in mind -- warfighting. As discussed previously, this mission relates to two objectives -- diplomatic utility and national security. Sufficient numbers are planned for attrition, and advancing technology is offered to increase force effectiveness, though fiscal realities makes such planning increasingly problematic. Quality and effectiveness are hallmarks of US military forces, though certain contingents cast counter dispersions.[11] The US military has generally had quality training and equipment to meet most contingencies -- though such expertise and assets cannot makeup for fallacious policy.

Political Considerations

The effect of the above considerations rest firmly on the political fulcrum. As economic and military considerations ebb and flow, so too do a nation's political considerations. A nation's political fortunes are closely tied to its economic and military robustness. Hence, in the end, the susceptibility of a nation's economic health and military power to degradation affect the nation's political viability. This interrelationship is one of the most critical and absorbing problems of statesmanship -- it involves the security of the nation and, in large measure, determines the extent to which the individual may enjoy life, liberty, prosperity, and happiness.[12] Other valid political considerations include, media relations, public relations, world geopolitical dynamics (alliances, coalitions, neutral, gray, third party, and enemy states).

Regarding the counter argument, a successful military operation generally results in great political benefits, thereby negating many negative considerations that may have existed. For example, President Bush was inundated with cautious overtones from many political quarters prior to the beginning of hostilities in the Gulf. Many deemed the political considerations of such an operation too costly. However, after successfully engaging his forces, the same man was regaled from the same quarters, and more, for his astute statesmanship and political guts. The president's polls were the highest of any president's in recent memory -- some rated him at 90 percent. Politicians can ride the wave of popularity following successful military operations, or can be swept up in the despair of a nation that uses its forces less than optimally. That said, a military force structure that operates with decreased vulnerability and increased effectiveness -- hence, more political flexibility -- seems advantageous.

With these basic definitions in hand, this paper now considers how each characteristic applies to forces on a continuum of deployment. Terrestrial force characteristics are discussed as the forces move from homebase to deployed and engaged states. How these same characteristics apply to two variations of space forces -- current fielded forces and current technologically feasible forces -- are then discussed. The analysis begins with a look at homebased terrestrial forces

Terrestrial Force Characteristics

Homebased:

Terrestrial Power Characteristics

↑ Strategic Agility
↓ Commitment/Credibility
- Economic Considerations
- Military Considerations
- Political Considerations

Home **Deployed** **Engaged** →

Figure One: Continuum of Operations and Characteristics of Homebased Terrestrial Forces

Strategic Agility

Generally, a terrestrial force enjoys its maximum responsive capability to respond to threats from any quarter of the globe when based at home. Upon receiving mobilization orders, and generating to deployable status, the force is ready to be deployed anywhere in the world at varying rates.

Obviously, ground forces must be either airlifted or sealifted to an area of concern, and this process takes time -- given a relatively large force commitment, this period could be weeks to months. Wings or squadrons of fighter, attack, bomber, or reconnaissance aircraft can be in place with large amounts of firepower within a theater of operations in probably the shortest period of time -- within hours to days.

Naval assets, depending where they are located when the decision is made to deploy them, are available anywhere from within hours to days to weeks. Generally, to generate a large enough force to be decisive in any contingency, the deployment time will be days to weeks for naval forces. Note “at home” for a naval carrier task force could in reality be “deployed,” if such a force is integrated and sustainable in its location. If this force is not located at the proper spot on the globe, relocating such force could take days to weeks. Sustained operations require arrival of more combat and support forces. However, naval forces themselves have theoretically indefinite sustainment capability given underway replenishment.

Commitment/Credibility

On the other hand, while terrestrial forces remain at home, the commitment of the nation to respond to a crises and its credibility with its alliances/coalitions, and its adversary, is at its ebb. The nation’s potential adversary may remain unimpressed, and affected by only whatever diplomatic rhetoric is exchanged. Even if the rhetoric includes outright or veiled threats of military response, the adversary may not receive Schelling’s concept of communication so important in diplomatic interchange. A force still at home may demonstrate an unwillingness to react militarily. (Nuclear alert forces are one exception -- though their applicability to most contingencies is negligible. Strategic airpower is another exception. As demonstrated in conflicts since the Gulf War, USAF long-range bombers have operated from the US and applied arguably decisive force around the world.)

The reasons for national non-reaction could be many, most of which could actually be valid domestic, national, or international concerns. However, the perception by the concerned parties is the same -- a fundamental lack of commitment and credibility of the nation to react with sufficient force to stem the tide of an international event.

Economic Considerations

Economic considerations for homebased forces tend to be neutral. Generally, the cheapest basing mode for a terrestrial military force is while it is at home. While units are homebased they subsist on a system that is integrated, streamlined, and reasonably efficient. They train effectively and efficiently based on many years of experience. Historically, accident rates, the results of which are noted by dead and injured personnel, as well as destroyed and damaged equipment, are lower while a unit is homebased.[13] The personnel and equipment are maintained most efficiently in this mode, as well. The result is that national treasure remains relatively unaffected. The force is maintained within budgetary constraints mandated by government, and no "surge" funding is required to meet unanticipated needs. The force is most easily maintained combat-ready at home.

An exception is that homebased forces could be attacked either by another nation's forces, or by unconventional warfare, or terrorist, forces. If attacks on homebased forces are broad, well targeted, and successful, the economic impact on the nation could be quite immense. However, if such an attack were to escalate into a war with the nation's survival at risk, the impact on the nation's economy by an attack on its homebased forces would be a relatively minuscule concern.

Military Considerations

Military considerations for homebased forces tend to be neutral, as well. Obviously, the susceptibility of a terrestrial force to damage or defeat is almost nil when it remains at home and the country is not at war. Military assets, both personnel and equipment, are in their least susceptible state when based at home. On the other hand, it is usually not operationally viable in such a position. (Exceptions include "on-station" carrier task forces and certain airpower capabilities.)

The exception to this concept would be a nation that experiences attacks on its military forces within its own borders. In this instance, the fact that the forces remain in an undeployed state actually makes them more liable to degradation from an attack, and the chance that the force will be degraded, or destroyed, is higher than if the forces were deployed. The military impact of such an occurrence could have drastic consequences. If the attack was but a prelude to a full-scale war, with the nation's survival at stake, the impact of the susceptibility of the nation's forces to such an attack would be great indeed.

Military forces exist to fight, except deterrent forces, which exist to demonstrate the capability to fight. If such is the case, it could then be argued that a force's susceptibility to degradation is not of paramount concern. The force must be used, and its use connotes the probability that damage and destruction will occur. Such an argument tends to negate some of the arguments previously made. It depends on where one stands what "tack" is taken on these concepts. However, regardless of one's position, it remains valid that an adjunct force that might reduce such risks would be beneficial.

Political Considerations

As economic and military considerations remain neutral for homebased terrestrial forces, so too do the political considerations. The susceptibility of the nation's political realm to domestic public, as well as international community, outcry and indignation is low -- so too is the chance for great political windfall given a successful military operation. As a result, the political leadership of the nation remains relatively flexible in their use of terrestrial armed force. For example. there is often little public outcry as homebased military forces are mobilized to help with natural and man-made disasters.

Considering the exception, as noted in both the terrestrial force economic and military considerations discussions, if the homebased force were to suffer degradation, or destruction, from an attack, political considerations could skyrocket. Again, if the nation's existence was at stake, this would be of little regard. However, if the attack was but a nuisance operation to demonstrate resolve or capability, the leadership of the nation could experience great disrepute. The dangerous consequence might be an inappropriate use of its forces in reaction to the humiliation, thereby escalating opportunities for drastic occurrences. This paper now turns its attention to terrestrial forces in a deployed state.

<u>*Deployed:*</u>

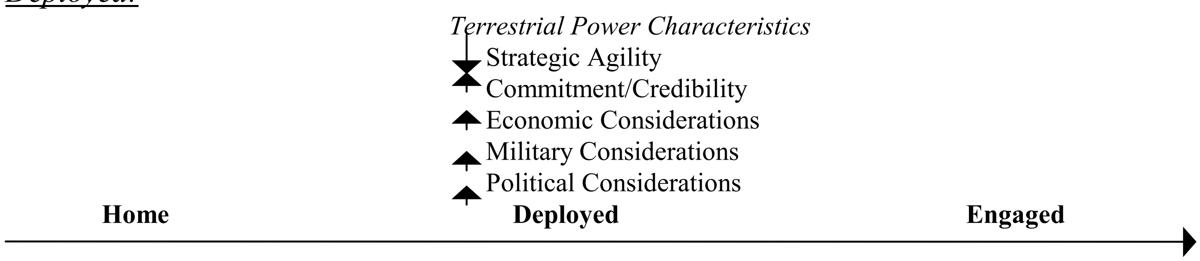

Figure Two: Continuum of Operations and Characteristics of Deployed Terrestrial Forces

Strategic Agility

As terrestrial forces leave their homebase and are committed to a theater of operations, their capability of redeploying to yet another theater decreases. This is an especially critical consideration today as US forces have drawndown to levels some consider unable to engage in two nearly simultaneous worldwide contingencies. There are many aspects to this dilemma.

First, if a force is committed to a theater to carry out the wishes of its political leadership, the wish to relocate it supposes a severe reason to do so. Doing so may result in unachieved objectives in the original theater. Second, as US forces are drawn down, the amount of force required to effect desired outcomes becomes critical. Theoretically, if just the right amount of force exists in a theater, moving any of it to another theater could result in either defeat or unwarranted losses in both theaters. Third, once a force is deployed and in place, it becomes physically difficult to relocate it to another area by virtue of logistics requirements, as well as such things as forward basing, overflight, and portage issues.

Commitment/Credibility

As US forces are deployed into harm's way, commitment and credibility of US resolve increases. Friends and enemies alike realize the significance of US leadership deciding to jeopardize personnel, equipment, national treasure, and domestic and international goodwill by sending forces into a theater of operations. The deployment of forces heralds the increased capability of the US to react. It is the perception of this increased capability that is the bulwark of demonstrating commitment and credibility. The perception of US resolve, both by friends and adversaries, is greatly increased by the deployment of forces.

Economic Considerations

As forces are deployed, economic costs of all kinds tend to increase. No longer is the force sustained by a system whose efficiency has been honed through constant use. Field conditions demand additional housing, food, water, transportation, medical care, maintenance, etc. as these functions must now be afforded apart from an established base. The force cannot necessarily be maintained within its legal budgetary constraints. The possibility of additional funds requirements to ensure adequate operations increases dramatically. This generally means other critical military requirements go wanting as fiscal resources are drawn from various other accounts to fund the current crisis.[14]

Historically, the accident rate for military forces increases as they deploy into unfamiliar territory. Emotions run high, units tend to train more "realistically," crews are not operating in territory, or under conditions, they are used to. In such a state, equipment tends to break down, and personnel tend to be injured or killed more than when forces are homebased.

Maintenance of equipment becomes more expensive and problematic at deployed locations. Major and minor maintenance on equipment becomes more difficult. Depots exist half a world away, and industry technical representatives are not always immediately accessible. Equipment is fixed with what was brought with the force. If the proper tool or part is not available, the entire system remains unusable. Inefficient transportation practices are put into use to field important parts to ensure as rapid fixes as possible. Costs increase as distances from homebase increase for terrestrial forces. These costs are varied and span the spectrum of military requirements.

It can be argued that economic considerations would be of no import if the act of deploying forces deterred war. This would be true given an electorate fully cognitive of essential facts, and politicians willing to risk such an act. Given a situation where deployment of forces successfully deterred war, even though costs were high in men, equipment and treasure, it would be difficult to prove that it was simply the act of deploying such force which resulted in peace. In fact, such a situation seems much too simple. Even with deployed force, it remains the dynamic of diplomacy that results in peace. With US media coverage, the loss of treasure, people and equipment would be on the mind of Americans, though peace may be at hand.

However, if one considers military forces exist to fight, and fighting generally connotes deployment of US forces, and deployments generally connote economic losses, which are therefore accepted, the arguments above hold little water. In other words, the nation cares little of losing national treasure if forces are properly deployed and engaged, with successful results. The fact that forces are being used as a viable diplomatic tool, or for national security purposes, could seemingly negate much of the argument previously made. Unfortunately, such an argument assumes an electorate in complete agreement with the nation's forces being put in harm's way, therefore willing to risk national treasure. This has seldom been the case.

Military Considerations

The susceptibility of US terrestrial forces to attack, and therefore degradation or destruction, increases as the force deploys to a theater of operations. Forces are outside of the protective boundary afforded by US airspace and sea buffers and are nearer the enemy forces' capability to strike. Terrorist or unconventional warfare forces can also attack with greater ease once US forces arrive in theater. As with economic considerations, as the distance increases away from home base, the military considerations of US forces increases. Both of these considerations affect US political considerations as well.

However, this susceptibility may be a mute consideration if one considers that military forces exist to fight, and fighting for US forces generally requires deployment, and deployments tend to risk degradation and destruction. With such a notion, the fact military forces may be degraded or destroyed has little or no significant impact on the decision to use them -- for they exist to be used. The risk of their destruction or degradation is of little significance, the argument goes, because such problems have been planned for in force structure and effectiveness decisions. Hopefully, the planning has been accurate. Such an argument has some validity, though so does the counter-argument of an electorate, and politicians, unwilling to take such risks.

Regardless, as US military forces deploy, the requirement (and attendant force structure and costs) to protect them increase. At various times in the deployment, the number of forces required for protection can meet or exceed those tagged purely for combat operations.

Political Considerations

If deployed US forces experience greater economic and military considerations than when they are at home, then so too do US political leaders' considerations increase. If US national wealth becomes susceptible to increased diminution, and US personnel are put at increased physical risk, US political leaders begin to walk a fine line as they carry out national policy by using terrestrial armed forces.

It can be argued that this point is only true if the political objectives for deploying forces are not achieved. If they are achieved, it is argued, then deployment of forces actually realizes an enormous political gain. The question that must be answered for this point to be valid is, "Are politicians willing to take this risk, based on recent deployment track records ?" If US public opinion still had events like Vietnam, Desert One, Somalia, or Bosnia on its mind, this line of reasoning seems debatable. Events such as Haiti, Grenada, and Kosovo could be looked at either way, while the result of Desert Storm could support this latter line of reasoning. This analysis now looks at terrestrial forces in the engaged state.

<u>*Engaged:*</u>

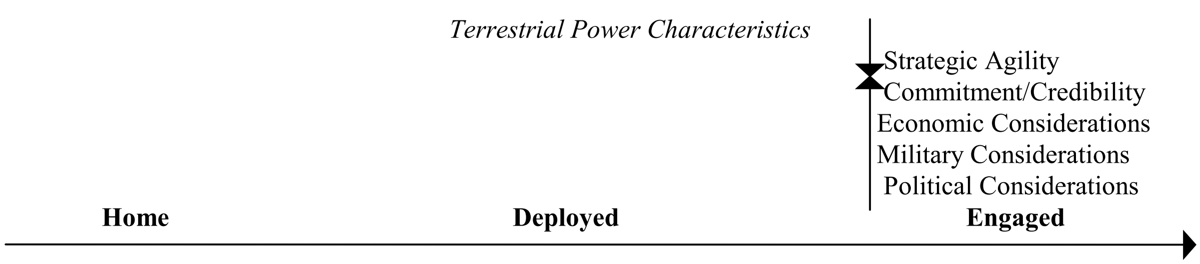

Figure Three: Continuum of Operations and Characteristics of Engaged Terrestrial Forces

Strategic Agility

Engaged force characteristics tend to mimic deployed force characteristics, at increased fidelity. That is, the concept of decreased strategic agility that held for deployed terrestrial forces holds true for engaged terrestrial forces, as well. However, the extent to which strategic agility is decreased is exponentially larger. It becomes much more difficult to move terrestrial forces to another theater once they are engaged. The problems of disengaging the forces are so immense -- politically, militarily, and logistically -- as to prohibit the thought of redeploying them elsewhere.

Commitment/Credibility

Commitment and credibility rapidly and exponentially rise when forces are engaged in combat. The adversary, as well as alliance partners, become strong believers in US resolve. The ultimate expression of resolve is to put national resources, such as humans and equipment, into direct contact with the enemy.

Economic Considerations

Unfortunately, as commitment and credibility rapidly increase as forces come into contact, so too does the reality of expending vast amounts of national wealth. Present and future weapon systems are exceedingly expensive, and operators of these systems are ever more highly trained. The economic impact of their losses is great, and the chances that this impact will be felt rises rapidly as terrestrial forces meet the enemy. War is always costly, but it continues to be waged because sometimes costs of not waging it are exceedingly higher. The other counter arguments remain the same as for deployed forces. The point continues to be, however, that if these considerations and costs can be mitigated, they should be.

Military Considerations

As with economic considerations, the susceptibility of losing military forces is exponential once rounds begin to be exchanged in the terrestrial battlespace. As weapon systems become ever more complex and expensive, their numbers dwindle. Therefore, each one becomes that much more militarily valuable. The loss of each system, and the highly trained operator, is that much more militarily significant. On the other hand, such systems are meant to fight, therefore their loss is generally accepted as attrition, and properly planned for in force structure debates. Hopefully, this is true, and the planning was accurate; operationally significant timely replacement of modern equipment and operators is problematic.

This reality affects, again, the amount of effort required to protect US and friendly forces. The ratio of force protection assets to actual "trigger puller" assets goes way up. This is even true, but to a lesser extent, for "stealthy" platforms.

Political Considerations

As with the previous discussion, the political vulnerability associated with forces engaged in combat is quite high. The moral and economic impact of one’s forces engaged in combat bring with it a high susceptibility of political leadership to ridicule and blame. As American mothers’ sons and daughters are injured and killed, and media coverage of civilian casualties, and even large amounts of enemy troops, is broadcast into American homes, domestic moral outrage will be quite high. Even without a protracted conflict to drain US coffers, domestic opinion of losing large amounts of high cost weapon systems will begin to emerge. The sum of this discontent will fall squarely on the shoulders of US elected officials -- most of who are interested in continual employment and prestige.

Obviously, this applies only to perceived losers. President Bush's 90 percent popularity rating in the wake of the Gulf War is evidence of the enormous political boon "winning" entails. The question remains however, are most politicians willing to take such risk ? The US was considered the out-and-out winner in Kuwait, but what were public perceptions regarding Korea, Vietnam, El Salvador, Desert One, Panama, Haiti, Somalia, Bosnia, etc.? It seems wildly successful results are far outnumbered by perceived questionable or outright poor results.

Comparative Spacepower Characteristics

With all of this said about terrestrial force characteristics across the spectrum of deployment, how are spacepower's characteristics affected on this same continuum ? Where does spacepower fit on this continuum?[15] Certain space forces constantly exist somewhere between the deployed and engaged states. In such a location, the asset is deployed. From such a deployed location, the asset can be employed.

A case could be made, however, space assets are always engaged. This concept stems from the idea that spacepower, due to its position, is constantly present in the mind of an entity, in that force can be immediately, or relatively rapidly, employed against the actor -- either virtually or really (much like terrestrial nuclear alert forces). This concept is termed "presence."

The question for spacepower today is what can be brought to bear against the actor? What capabilities are "present" in the mind of the actor ? As previously discussed, spacepower is limited today in what "force" it can provide. Such limitations, however, do not negate the applicability of this analysis. To the contrary, this analysis demonstrates the advantages of fielding greater capabilities.

In order to demonstrate this, military force characteristics will be discussed as they apply to spacepower, both in current capabilities and in current technologically feasible capabilities.

(Such capabilities include space control and force application -- both of which depend on US policy makers' decision and direction to field.) The delta between these variations demonstrates the advisability of pursuing greater spacepower capabilities.

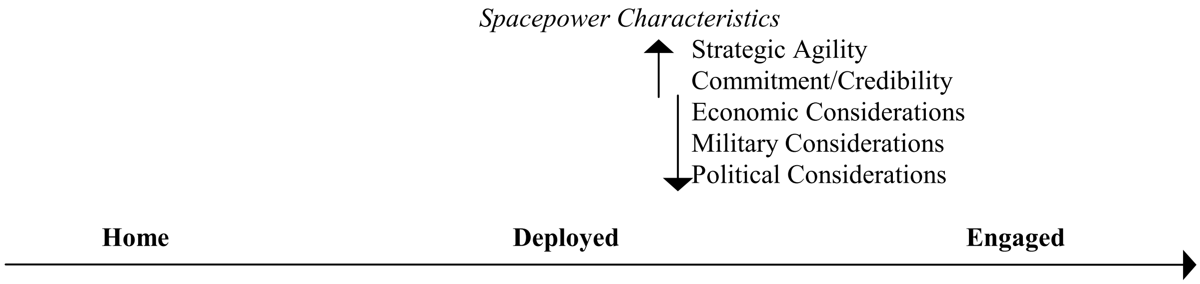

Figure Four: Continuum of Operations and Characteristics of Spacepower

Strategic Agility

Though effectively forward deployed, and due to physical capabilities associated with its medium, spacepower retains a relatively responsive capability. For example, when Iraq invaded Kuwait on 2 August 1990, the first coalition assets to make their presence felt on scene were not air, naval, or land forces, but rather the allied space systems already on orbit high above the gathering storm.[16]

Depending on the distance apart of two (or more) areas of interest, space forces, due to their position and ability to loiter (for certain assets), could conceivably accord influence over ("effect") all such areas from the same position for years, if need be. Constellations of satellites could work in union to effectively influence areas separated by vast overland distances.

Satellites can also be moved. Though today this process is slow, a few degrees per day, and expensive in fuel requirements, the vantage of space allows a broad footprint. This footprint, even if moved only degrees per day, casts a large effective area relatively rapidly. Capabilities now in development, including smaller, more maneuverable, cost-effective satellites, as well as transatmospheric vehicles, will allow space forces yet greater agility.[17]

Given today's standing space force agility capabilities, as well as today's technologically feasible capabilities, no longer are the US military and policy makers restrained from engaging elsewhere when their forces are deployed or engaged in another area of the globe. US space forces retain strategic agility to "effect" virtually any area, any time.[18]

This agility is conditional, however. It depends on the degree to which the particular space force resource is designed to operate. If the resource is self-reliant, or not supporting a terrestrial system, it maintains its maximum agility. If the system supports a terrestrial system, e.g. cueing sensors, it then is limited by the terrestrial system's agility, unless it retains a networked, constellation-based capability to support multiple, geographically separated terrestrial systems.

Commitment/Credibility

On orbit space forces can be thought of as always deployed, or in certain instances, even engaged. Given space assets that are technologically feasible today, the commitment and credibility of such a force is inherent. Adversaries no longer need question US commitment. No longer do costly deployments of personnel and equipment need be carried out in a show of force.

With spacepower, the force exists on station, all the time, or at least can get on station very rapidly -- depending on space force basing modes. The paradigm of putting forces at risk is replaced with the notion that exactly because forces are not at risk, the plausibility of use of such force increases, thereby increasing the notion that US policy makers will use it -- commitment and credibility.

The degree of commitment and credibility, however, is limited by today's actual space forces. The lack of an autonomous force application capability to directly influence an actor mitigates the forces' ability to demonstrate commitment and credibility. (This capability need not even require kinetic or directed energy weapons; information warfare systems would be sufficient, maybe even superior. In today's knowledge age, such systems could influence just as well, if not better, than more conventional type weapons.) In other words, today, though certain space forces are "present" in the mind of the actor (reconnaissance platforms, for example), their lack of ability to directly influence requires the old paradigm of putting terrestrial forces into harm's way to demonstrate US commitment and credibility.

Economic Considerations

Today's actual space forces, as well as those technologically feasible, do not require escalating support and operational costs as terrestrial forces do upon deployment and engagement. The majority of spacepower costs are those incurred as sunk costs, which is paid at, and prior to, acquisition. Maintenance costs and life cycle costs can be drastically reduced with a lift capability allowing either on-orbit replenishment, or rapid, contingency-oriented delivery capability, such as a TransatmosphericVehicles or reusable Single Stage to Orbit systems (i.e. SMV/SOV/MSP).[19]

The costs of attack on homebased spacepower resources depends on the systems' basing modes. Orbital systems, obviously, are least affected by such an attack, unless the systems are singularly tied to, and reliant upon, a ground based station. Reusable systems are most vulnerable to this situation and efforts are required to minimize this potential. Today's fielded technology presently requires widely dispersed ground stations, some well outside of the protective boundaries of the US. This presents a significant security problem for today's US space assets. Considering presently available technology, such bases could be maintained well inside US territory, allowing worldwide control via constellation interconnectivity and providing maximum security.[20]

Problems with space forces include their extremely high initial cost. The loss of one such asset would be felt much deeper than the loss of multiple terrestrial force resources. This fact calls for the early establishment of a space control capability to ward such possibilities off. As in airpower, superiority of the medium is crucial to the ability to operate from the medium. It also calls for rapid realization of cheap, responsive lift to ensure assets achieve position safely.

Military Considerations

Like homebased terrestrial forces, the susceptibility of spacepower assets to damage or defeat is relatively lower than deployed or engaged terrestrial forces. This implies a US space control capability to negate any space-borne, or surface launched, capability against its systems. Such a system is technologically feasible today, though one is not fielded. If attempting to influence a space-capable actor, this present limitation could negate the concept of spacepower's lowered susceptibility to degradation and destruction. Additionally, as previously discussed, foreign ground stations need to, and can, be minimized to negate security problems. As previously mentioned, this is a potential liability today. Technologies presently exist to minimize this risk, allowing ground stations to be located within the contiguous US, relaying data along constellations (the commercial space industry leads the way in this command and control capability).

Tied directly to economic considerations, relatively fewer space assets can be deployed as compared to terrestrial assets. This is due to high cost, but also to the inherent multiple-mission characteristic of space assets. Both of these issues could cause the loss of just a few space assets to adversely affect military operations -- much more so than the loss of similar numbers of terrestrial assets. Again, such a fact harkens to the need for early space control capability.

Another military consideration is the manpower requirement of terrestrial forces vice space forces. Generally, today's services all are failing to meet retention and recruiting thresholds so vital to maintaining combat power. All of this, while force requirements are on the increase. As Secretary Peters (SecAF) pointed out in his Air Force Posture Statement on the FY 01 Air Force Budget, "We (the Air Force) are now 33% smaller and 400% busier."

Certainly, because of the relatively limited "effective" range or coverage area of terrestrial forces, more personnel (and equipment and infrastructure -- both operational and support) are required to "effect" the same amount of area as compared to the same requirements for space forces.

For example, one squadron of F-15Es (24 UE with approximately 250 operators and maintainers) can "effect" a very small regional area -- and must generally do so from a forward deployed base. On the other hand, one GPS squadron (and there is only one -- the 2nd Space Operations Squadron at Schriever AFB, Colorado) "effects" the globe, all the time, simultaneously, with 24 satellites and less than 150 personnel (operators and contractors [maintainers]) -- all from their homebase. There is no reason to assume space force application and space control squadrons could not enjoy the same advantages.

The bottom line to the military consideration of space based assets is decreased emphasis on force protection and manpower-generation requirements. In all, the requirement for large force protection efforts decreases when fully capable spacepower assets are employed.

Political Considerations

Due to the relatively low economic and military considerations spacepower resources enjoy, as compared to deployed and engaged terrestrial forces, the political repercussions of utilizing such assets is similarly lower. Whereas, policy makers have to contend with possible loss of troops' lives when considering deploying or engaging terrestrial forces, the use of space forces carries no such political liabilities, when considering unmanned assets, and little chance of political liability when considering manned assets. As then-Major General Roger DeKok, Air Force Space Command's Director of Operations and Plans, remarked in an interview with the author in 1995, "Satellites have no mothers."[21]

Given today's technologically feasible capabilities, as well as today's fielded systems, the inherent lack of political problems with using spacepower is instrumental in making it an extremely politically flexible tool of national power. It can be used with little regard to political ramification at home in many situations previously deemed as too politically sensitive given terrestrial force employment considerations.

National policy no longer need be tied by visions of dead Marines being paraded across a television screen. Spacepower can complement and support the other elements of power while not increasing chances of early US withdrawal due to loss of life or equipment.

On the other hand, as with other considerations, due to economic and military implications of losing just a few space assets, political ramifications of such a loss are high. Space control remains a high economic, military, and political priority if deploying a fully functional military space capability. Today, without this space control capability, political, economic, and military ramifications of losing spacepower advantages to a space-capable adversary could be high. Considering the high degree of space support terrestrial systems have come to rely upon, loss of such capabilities could be disastrous. Additionally, this degree of reliance is increasing.

Analyzing the characteristics of spacepower, the delta between how they apply to today's actual space forces, and to today's technologically feasible space forces, demonstrate the advisability of pursuing more advanced spacepower capabilities. While today's actual space forces have certain advantages when compared characteristically to terrestrial forces, they also have many limitations. Conversely, today's technologically feasible space forces seem to demonstrate certain characteristic advantages when compared to terrestrial forces.

Overall Comparison:

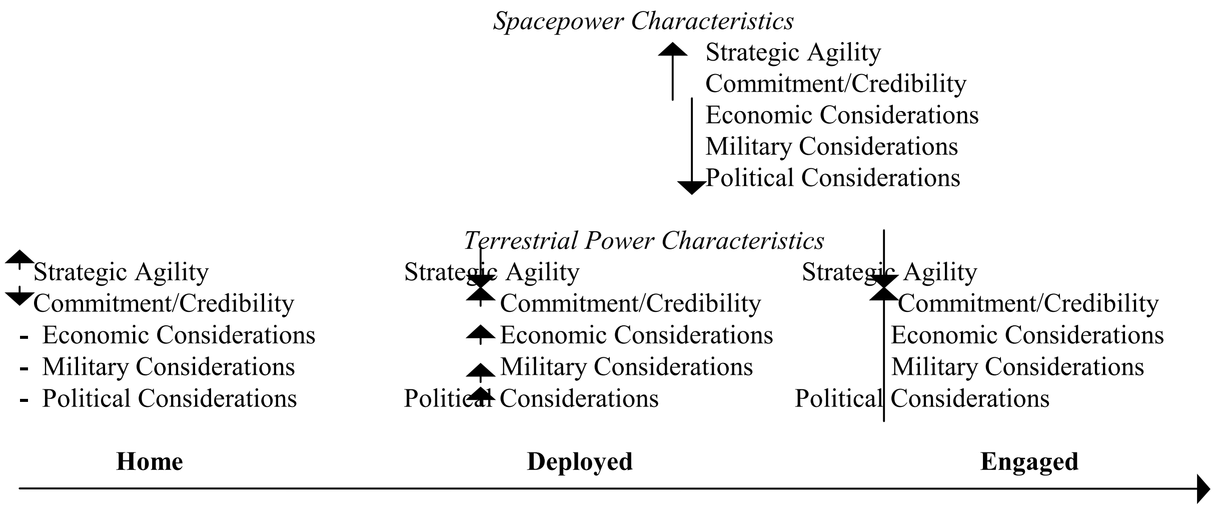

Figure Six: Continuum of Operations and Characteristics of Spacepower versus Terrestrial Forces

Risk management is the hallmark of military characteristics as they apply to spacepower. Spacepower, due to its inherent characteristics of non-provocativeness of position, decreased economic, military and political considerations, coupled with increased strategic agility and demonstration of commitment and credibility, can act to *influence* entities with decreased risk as compared to terrestrial forces.

To a certain extent this is true given today's fielded space systems, though limitations previously discussed, such as a lack of force application capabilities, mitigate some benefits. However, given a space force which is technologically feasible today, the benefits that spacepower brings to the diplomatic forum seem to be great, as compared to terrestrial forces by the characteristics of strategic agility, ability to demonstrate commitment and credibility, and economic, military and political considerations.

Many of the considerations discussed with regard to terrestrial forces were moderated by views that military forces exist to deploy and fight. Such views hold that since this is so, the forces' economic, military and political considerations need not regard their degradation or loss as a primary limiting factor in their use.

While this notion has credence, it remains true, it seems, that the ability of an adjunct fully functional space force to affect an actor in a similar way, but without risking such loss or degradation, has great advantages. From an analysis of military characteristics as they apply to terrestrial forces, today's actual space force, and to a space force technologically feasible today, it seems such a force would be beneficial.

Conclusion: Political Flexibility

It is said the military is the extended arm and fist of diplomacy. Inherent in this concept is political flexibility to use military force. If the domestic or international political ramifications of using military force is too great, the likelihood that government will resort to it seems low -- and the adversary will remain un-"effected." This notion is modified, however, when considering a fight for national survival or in operations of similarly great import. In other, more routine operations, if left without this sometimes last recourse, government could be left impotent to advantageously influence events, and may be forced to stand by and watch events take place which are against the national interest.

This political inflexibility to resort to using military action results from many factors. Considering recent crises the US has been embroiled in, however, it seems economic, military and political considerations are paramount. The problems, as well as advantages, inherent with terrestrial forces and these factors have been discussed. It seems, as the probability of actual military confrontation increases, so too do the considerations. Hence, the political flexibility to even use the military instrument in the first place tends to decrease.

However, due to some of the advantages of spacepower discussed above (tempered by today's limitations and bolstered by today's technological possibilities) these considerations can be drastically reduced across the spectrum of military action. This decrease allows much more political flexibility, thereby allowing the government another realistic diplomatic tool with which to ensure US national interests are met.

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[1] This distinction is drawn in order to demonstrate potential. Additionally, to conduct an analysis solely with forces that do not exist would be to make a wholly specious argument.

[2] Phillip Meilinger, Colonel, USAF. "Ten Propositions Regarding Airpower." A paper written in his position as Dean, School of Advanced Airpower Studies, Maxwell AFB, Alabama. August 1994. p. 3.

[3] Homebasing does not necessarily imply US basing. Rather, it denotes a force located in its primary position, with all of its required logistics for permanent operations and sustainability. A fighter wing is homebased if it is at its primary location, e.g. Lakenheath, United Kingdom, whereas a carrier battle group is homebased (for the purposes of this discussion) if it is totally integrated and sustainable -- theoretically, this could be "on station."

[4] Department of the Air Force. *Global Presence 1995.* (Washington: GPO, 1995), 13.

[5] Thomas Schelling. *Arms and Influence.* (London: Yale University Press. 1966), 36.

[6] Ibid., Ch. 2.

[7] See *War and Anti-War,* (Boston: Little, Brown and Company, 1993) by Alvin and Heidi Toffler for a thought-provoking treatise on the evolution of warfare and technology.

[8] *Global Presence 1995,* 11.

[9] Ibid.

[10] As was the case when Checkmate initially briefed General Horner on the strategic air campaign against Iraq in early August 1990. When the General determined they had no defensive plan, he reacted with dismay.

[11] Many quarters prior to the Gulf War were doubting the effectiveness of high cost US weapon systems. Such contingents were noticeably quiet after the war ended and US technological superiority was widely recognized.

[12] Edward M. Earle. "Adam Smith, Alexander Hamilton, Freidrich List: The Economic Foundations of Military Power." *Makers of Modern Strategy*. (New Jersey: Princeton University Press. 1986), 217.

[13] This is most evident in the famous "Sunday Briefing" given the first day of all Red Flag deployments. This is a mandatory pre-exercise flight safety briefing and offers statistics showing a relatively higher accident rate. The point of the briefing is not to become a statistic. The USAF Flight Safety School also teaches that accident rates at deployed locations tend to be higher, thereby requiring increased command and safety vigilance.

[14] One need only look at recent testimony of various service chiefs and secretaries to Congress regarding unfunded requirements due to larger than expected operations costs in the Kosovo campaign to illustrate this point.

[15] This assumes the asset is successfully launched and placed into proper orbit, or is capable of transiting the proper orbit inherent in carrying out its mission.

[16] Benjamin S. Lambeth, "Air Power, Space Power, and Geography," *The Journal of Strategic Studies*, June/September 1999, pg 73.

[17] See technology discussion, including the "enabling" technologies for such an advance, in Chapter 2.

[18] Except for current systems already on orbit, much of this argument is mute if the US does not pursue technologies now in development to ensure rapid, responsive, affordable space lift. Without a capability to place forces into proper position rapidly and affordably, be it orbital or suborbital, spacepower's strategic agility is limited to present on orbit assets. Shuttle missions to fix satellites or place assets in orbit are prohibitively expensive and time consuming, thereby driving up economic, military and political considerations. With such a limitation, on orbit spare capabilities take on greater significance -- though, as compared to rapid launch capabilities, still driving up costs.

[19] Proof-of-concept of such systems is occurring now. See Durnheim, "DCX Proving Initial Operating Concepts."

[20] IRIDIUM will have a constellation interconnectivity capability.

[21] Interview with the author, Peterson AFB, Colorado, 13 March 1995.

Chapter Four

Presence, Influence, and Influence through Presence: A New Notion of Deterrence and the Infliction of National Will

Presence: 6. ... felt to be close at hand.
-- Webster's Dictionary

Influence: ... 3b. A power thought to emanate from the stars.
-- Webster's Dictionary

We are entering an era -- if we have not already entered it -- when the use of space will exert such influence on human affairs that no nation can be regarded as a world power or remain a world power unless it possesses significant space capabilities.
-- General Robert T. Herres

Overview

By its very nature, aerospace power is expeditionary. It can rapidly project power, influencing events, over great distances. Advanced spacepower capabilities make this reality even starker. It can be present virtually all the time, influencing (or "effecting") an adversary at will.

This chapter discusses presence, its relationship to influence, and how this relationship affects an adversary. This discussion is done from both general military and specific aerospace perspectives. Webster's dictionary defines presence as "the state or act of being present." "Present" denotes being "alert to circumstances," and "readily available." An entity is present when it is physically "close at hand," or even perceived to be so. Hence, an entity can be present when it is physically so, or merely notionally so.

This chapter deals with "presence" in two ways. First, it discusses the capability of military forces to be "present" in, near, or over an area of interest to the US. Second, it discusses two concepts of presence -- real and virtual -- and how they relate to the space dimension of aerospace power. Presence allows influence.

Influence connotes the power to affect events in a manner beneficial for the instigator. This power stems from the ability to have sufficient force in a position to either directly, or indirectly, affect events. This thesis posits two different, but sometimes complementary, forms of influence -- coercive and persuasive.

Coercive influence intimates the use of force. Compellance of an adversary is generated through implied, or real, forceful pressure. If a change in adversary action is not forthcoming, actual physical force is often resorted to. Historically, this type of influence has been the purview of military forces. Coercion has been the paradigm by which the military has operated since men were first placed in rank and file, and it has played an inherent part in discourse among *homo sapiens* since time eternal. It exists today, and will continue to be the predominant *raison d'être* for military force structures.

The paradigm of coercive influence was and has been tempered, and possibly changed forever, with the advent of technology and operational doctrine that allows a more benign, but just as real, type of influence -- persuasive influence. Persuasive influence connotes action taken by one side's forces to benefit another side in some way. Noteworthy is the lack of threatening force to effect a change in an entity's behavior.

Supportive inducement is the hallmark of persuasion. Entities are persuasively influenced via offerings of capabilities or resources otherwise technologically, politically, or fiscally unattainable on their own. General Billy Mitchell actually hinted at the applicability of airpower to this concept when, in 1925, he wrote in *Winged Defense,* "Just as power can be exerted through the air, so can good be done, because there is no place on the earth's surface that air power cannot reach and carry with it the elements of civilization and good that comes from rapid communications."[1] Today's aerospace power has demonstrated this capability many times, from humanitarian airlifts to space-based emergency communications for disaster areas.

Though an oft-conducted reality, this type of influence has been lacking in military theory. Blunt application of force is anathema to this concept. Persuasive influence can play a complementary -- and sometimes leading -- role in achieving national objectives.

As airpower came into vogue as a tool for influence, parties around the world became alarmed with other nations' abilities to attack territory from the air. Such a capability was deemed by some to be dangerous and destabilizing. The mere fact airplanes could conceivably be overhead any city, at any time -- present -- to influence actions of any nation, became traumatic thoughts for many states.

Such notions were used in various attempts to denigrate airpower in its formative years. One of the more famous examples of trying to "backdoor" this rationale at the expense of advancing airpower was the "revolt of the admirals" in the B-36 controversy of 1949. The problem was the air was already militarized, had been for years, and trends were toward more, rather than less, military capability from the air.

With all that in mind, this chapter analyzes spacepower's ability to influence entities through presence. It begins by discussing three requirements for "effecting" an adversary via presence. It goes on to analyze "real" versus "virtual" presence, and how presence results in influence, both coercive and persuasive.

The chapter then takes a short look at presence and influence in future conflict. It asks the question "what may future conflicts look like, and how can spacepower be integrated into the application of military capabilities to achieve national objectives?"

The chapter ends with an historical analysis of spacepower's ability to influence and persuade. It inductively analyzes spacepower's ability for world-wide influence via virtual presence by discussing the US reaction to *Sputnik's* launch, the push for world-wide space treaties, the worldwide public discourse associated with the Strategic Defense Initiative (SDI) debate, and the on-going worldwide political discourse about space weapons.

Note this latter analysis is inductive vice deductive. Since a fully functional and integrated spacepower capability does not presently exist, no direct evidence is available to deduce spacepower's ability to influence through presence. Therefore, this analysis must infer spacepower's capability to influence through presence. Influence is evidenced from reactions of nations dealing with questions of spacepower deployment—from the benign capabilities of early satellites like *Sputnik* to the more capable systems like SDI, and kinetic energy anti-satellite weapons (KE-ASAT).

Three Requirements for Presence

The essence of military power's effectiveness is that it is able to "effect" an adversary. For example, a carrier battle group can *physically* affect an adversary when it close enough to the adversary for its aviation assets to be within range of viable targets.

The first requirement for presence is that the medium from which military forces operate must be within operational range of an adversary's vital interests. A second requirement for presence is that the force must have the ability to physically access specific targets given its resources. The force must be able to "see" or "effect" the appropriate part of the adversary's system to elicit the desired reaction from the adversary. Said another way, not only must force be in operational proximity, but also it must be able to physically affect the adversary with proper resources. A third requirement is the ability for military force to remain in proper position to affect the adversary -- it must be sustainable. Logistics considerations, fuel requirements, human endurance, and political concerns are but a few limiting factors. In short, the force must be sustainable in such a position to affect the adversary in order to be truly “present.”

All military forces have the ability to project presence to certain extents. Part of the art of military command is to discern requirements and implement plans based on customizing the efforts of all military forces to effect outcomes. Certain instances call for large elements of ground power, while others call for the rapid introduction of ground-based or naval air to a theater. Most instances, however, require the studied introduction of numerous forms of military power complementing each form’s capabilities and limitations. The game is to successfully employ each element of military power based on its maximized "presence potential."

Terrestrial Forces and Presence

Based on the medium from which they operate, terrestrial forces are limited in the extent to which they can project presence -- some more than others. Due to this limitation, doctrine generally calls for differing elements of terrestrial forces to be supported by other elements to carry out their missions.

Ground forces, obviously, are limited in their ability to project presence beyond the coverage of their assigned air, artillery, armor, and infantry units. Naval forces are limited by their medium’s equipment capabilities to reaching only so far to project presence. Air forces, often considered the element able to project the “most” presence the farthest, are similarly limited. Obviously, since air enshrouds the other terrestrial mediums, forces that operate within it have an increased advantage to project presence than do those underneath it. However, political and territorial claims limit this ability most of the time. Interestingly, all elements’ abilities to project presence are maximized by each element’s airpower capability -- manned or unmanned.

Regarding the second requirement, terrestrial forces all have unique capabilities to "see" and "effect" targets within an adversary's system. Each element's ability, however, is limited in certain ways. Ground forces generally can only "see" and "affect" circumstances directly or relatively very near its present position. It relies heavily on the other elements of military power to "see" beyond its own capabilities, and it can "effect" with weapons and personnel only to the range of its weapon systems. Naval forces can "see" and "effect" over longer distances within its medium due to lack of terrain limitations and medium-optimized weapons. However, they remain limited to their weapons' and reconnaissance systems' ranges. Air forces are generally called on by the other elements to provide long range "see" capabilities for them. Air force's "effect" ranges are generally accepted to be longer (as the concept of strategic bombing connotes).

Regarding the third requirement for sustainability to project presence, terrestrial forces are limited by the environment in which they operate. Simply stated, operating among air molecules requires constant dissipation of energy in one form or another, with limited ability to replenish *in situ*.

Ground forces on the offensive must be replenished "on the move," requiring vast logistics systems. Defending ground forces generally use fewer resources and therefore require less logistics support. However, the basic factor limiting the operational ability of a ground force is the amount of resources it is capable of being resupplied. Naval forces can generally resupply at will. However, the force which is being resupplied, even when under-way replenishment is taking place, is necessarily out of commission for the period of time required to complete the operation. Air forces are similar. They can generally resupply at will, and can even resupply underway for certain resources.

This ability to resupply underway for naval and air forces is a great advantage to project presence in that the force can sustain operations for longer periods of time than if a return to base were required for every replenishment operation. However, this capability is not a panacea. Certain resources cannot be replenished underway, requiring a "withdrawal" from the area for resupply. For example, once an airplane expends its ordnance, or exceeds its crew's endurance, it must depart its position -- it is no longer "present." Naval assets, if replenished underway, have much longer dwell times measured in months.

This is not to imply terrestrial forces are limited to the point of non-applicability by their presence restrictions. The art of employing such force is to work within these restrictions to field a credible force based on each force's limitations. This has been done rather well in past conflicts. It has also been done not so well. The key is that these limitations do not necessarily negate the effectiveness of such force, though it is a planning and doctrinal consideration.

All terrestrial forces, given various exceptions for subsurface naval forces, operate in Earth's atmosphere, which influences the way things move (e.g. through aerodynamic drag and lift), weapons effects (blast), and the utility of man.[2] As discussed in Chapter Two, space is a significantly different operating medium from the terrestrial mediums.

Space Forces and Presence

Presence is the virtue most often associated with space forces -- though limitations exist. This may be so because people subconsciously compare spacepower's ability to meet the three requirements for presence to terrestrial forces' abilities. The following comparison does so not subconsciously, but rather in a straightforward way.

Regarding the requirement to be within operating range of an adversary's vital interests, spacepower surrounds all of the other military operating environments, thereby retaining a position superior to every other military element (in most cases). Exceptions are those missions that require on-site man-in-the-loop such as boarding parties and certain urban insurgency and special operations.

Because space surrounds all other mediums, and space assets can be deployed in such a way to encompass the globe simultaneously, it is uniquely suited to be within operating range of areas of an adversary's vital national interests. However, today's fielded space force's ability to project presence is limited by the positioning of on-orbit assets. These assets must be at the proper place to affect the adversary. If they are not, costly (in fuel and time) maneuvering must be accomplished. Due to their altitude, and depending on system capabilities, they may be able to continually affect large areas of the earth even as they relocate, but if the subject is not within the system's field of regard, presence remains unachieved until relocation has occurred. Additionally, the absence of a space force application capability limits spacepower's ability to be completely "present" in the adversary's mind.

Space systems that are technologically feasible today may be able to remedy this situation. Rapid, responsive lift capability (MSP, SMV and SOV technology), as well as large constellations of small satellites (microsat technology), could either quickly place assets at the proper location, or retain the capability to affect virtually the entire globe due to the number and positioning of satellites in a constellation.

Today's actual space capability provides certain presence advantages over terrestrial forces, while also being limited in many ways. Today's technologically feasible space forces, on the other hand, could hold many more advantages, with fewer limitations.

Regarding the second requirement to be able to physically access specific targets: Because space vehicles operate with vantage and speed advantages, (allowing a single satellite [or a constellation] to “see” [and effect] enormous areas of the Earth[3]), not only can space assets theoretically affect assets in other mediums, they can also affect targets in all of the other forces’ operating mediums. Targets ripe for such influence include grand strategic, strategic, operational, as well as some tactical ones.

That said, terrestrial forces remain the only forces capable of providing presence where on-site man-in-the-loop requirements exist. Today’s actual space forces are limited by their sensors’ inabilities to detect many things not directly accessible. Additionally, today’s actual space forces are functionally limited by their inability to directly apply force. Technologically feasible space forces, however, have this capability. Such a capability, coupled with improved sensor capability would allow space forces to more fully realize the advantage of presence as compared to terrestrial forces.

The third requirement is sustainability in such a position to continually affect an adversary. Space forces, once on orbit, can sustain altitude without expending fuel.[4] Space forces located at the libration points can theoretically sustain position indefinitely, and due to the gravity well phenomenon, can continually affect adversarial targets from a position of relative energy advantage.

However, space forces face the same limitations as terrestrial forces for replenishment of such non-on-site replenishable resources as kinetic energy weapons and, depending on the orbit or position of the asset, fuel. In fact, such instances are a greater detriment to space forces due to the difficulty of access as compared to terrestrial forces.

Today’s actual space forces are severely limited in this respect due to inadequate replenishment launch capability. Technologically feasible space forces demonstrate technical innovations, such as high-energy lasers for directed energy weapons, and cheap responsive lift for fuel or kinetic energy weapon replenishment of on-orbit assets, which could remedy such limitations. [5]

<u>Real versus Virtual Presence</u>

Presence is a perception by the adversary that the will and tools exist for the US to act. As stated previously, the ability to project influence can either physically or notionally exist. Therefore, the actual existence of such abilities is transparent to the adversary. Real or virtual presence then, is a factor for consideration by US military and political leadership.

Real presence connotes the physical existence of an ability to affect an adversary. Such presence is discussed in the section above concerning presence and military power. A carrier battle group visibly off the shores of an adversary is real presence, as is a tank platoon positioned to strike on a battlefield, or a four ship of F-15Es flying a “Southern Watch” sortie over southern Iraq, or a constellation of on-orbit, multi-functional satellites that the adversary knows is there.

Such presence, as previously discussed, is dependent on three requirements, that is, the force must be in proper position, it must have the means to physically affect the adversary, and it must be able to sustain itself in an operationally significant position. Note that today’s actual space forces, though they can be present, are limited in what they can do -- a question of influence, soon to be discussed.

Virtual presence, on the other hand, connotes the same effect as real presence through the essence of existing forces. This is an ethereal concept that all forms of military power have to certain extents. The tank platoon previously discussed could exert presence just by the fact of its sheer existence, though due to deployment times, etc., may not wield the same virtual presence as a B-2 bomber on the ramp at Whiteman AFB. The reason is the adversary knows the B-2 could be employed much more rapidly than could the tank platoon from its homebase -- with the potential of a lot more firepower. Another example of virtual presence is the carrier battle group that initially demonstrates real presence by being visibly off the adversary's coast, then sails over-the-horizon. It could be sailing away from the conflict, or it could be repositioning, well within effective range -- all the adversary knows is that the potential for the carrier to act is real.

Inherent in this notion is the ability to "know" an adversary's disposition or actions in lieu of real presence. Information technology is the key. Discussing the difference between what it termed "forward presence" (a form of real presence), and "post-Cold War" detached presence (a form a virtual presence), the USAF's *Global Presence* document states:

> To use an analogy, during the Cold War, America was like a cop permanently guarding the door of every bank around the globe. Changes in the security environment coupled with technological improvements and force reductions altered America's need to continue in this role. Hence, America replaced 'the cop on the beat' with 'video monitoring and alarm systems' linked to joint military capabilities that can be brought to bear wherever and whenever necessary. This monitor and alarm network consists of space-based and air-breathing platform sensors and other information-gathering systems. In most instances, information combined with forces that can rapidly respond with the right mix of capabilities can achieve US goals. On occasion, information alone may be enough to attain US objectives. Of course, in some regions of the world a physical presence is imperative; however, there may be circumstances when such a presence is counterproductive. In instances where a physical presence is not preferred, information capabilities provide America the option to visit the 'bank' as often as it wishes to check the integrity of the system.[6]

Note virtual presence does not imply "bluffing" to achieve the presence effect. Such an attempt may work temporarily, but a challenge to virtual presence is always a high probability. Such a challenge requires the demonstration of real presence to convince adversaries of US intent and capabilities.

This concept applies particularly well to spacepower's ability to project presence. Except for very few potential adversaries, most have limited to no capability to realize the existence of US space forces in effective position.[7] Therefore, the ability of US space forces to project real presence is restricted to demonstrating capability; that is, supplying "proof" to the adversary it exists and can be effective.

In lieu of political and military situations that would support such demonstrations, US space forces must rely on the concept of virtual presence to be effective. Because space forces can uniquely meet the three requirements previously discussed to achieve presence, adversaries are apt to feel the presence of spacepower -- they can be influenced. This influence can be coercive or persuasive in nature.

Coercive Influence

Many theories of war have emerged over the years. However, all have had a common theme -- coercion, or force, is used to effect a change in desired behavior of one's enemy. The theories of the Prussian soldier Carl Von Clauswitz are the baseline of most military theories since his time. Whether it be Mahan or Corbett writing of naval theory, Douhet or Mitchell or the Air Corps Tactical School writing of air theory, or Schelling or the myriad of other writers discoursing general conflict theory, all base their work on the use of force to compel an adversary to do another's bidding.

Clausewitz has been paraphrased often with regard to the notion that, "War is the continuation of politics by violent means." One of his main theses includes his idea of the Trinity of War, which is bounded by three principal elements: the nation's people, the nation's army, and the nation's government. Clausewitz wrote it is the people who account for the "blind natural forces of hatred and violence" which permeate the nature of war. It is the army, and its leaders, which account for war's "chance and probability," implied through courage and talent. The final element of the Trinity, the government, accounts for the basis upon which war is waged

-- political aim(s). To win a war, he posits that all three elements of the Trinity can be objectives to be affected by force, or threat of force.

However, the ultimate, overriding objective must be the *nation's will to fight*. This national will can be decimated by affecting all three elements of the Trinity. An enemy's population may be made to incur such hardship that revolt against their government occurs, or the government bends to adversarial demands in order to arrest its population's suffering. An enemy's forces can be completely defeated on the field of battle, and their nation can be occupied, thereby completely negating the enemy's will to fight. The enemy's third element of the Trinity, its government, can experience such adverse political repercussions, either from its population, or its alliances, that it may lose the will to carry on the fight.

This classical nature of war has been predominant throughout the centuries. Alvin and Heidi Toffler, in their book *War and Anti-War,* note that this type of warfare grew out of their "First Wave" society, which existed based on requirements for vast amounts of land upon which to grow sustenance. Such an agrarian culture demanded an ability of adversaries to gain land, and this was generally accomplished through warfare.

The Toffler's second generation, or "Industrial Wave," added technology to the warfare equation. Industrial economies demanded more markets for their products and such economies fielded ever more technologically advanced forces to overcome both First Wave and Second Wave enemies. "The very biggest and most murderous wars during the industrial age were intra-industrial -- wars that pitted Second Wave nations like Germany and Britain against one another, as each one struggled for global dominance while keeping the world's First Wave populations in their subordinate place. The ultimate result was a clear division. The industrial era bisected the world into a dominant and dominating Second Wave civilization and scores of sullen but subordinate First Wave colonies."[8] That is, Second Wave civilizations coerced First Wave civilizations, as well as each other -- all through increased military technology, and associated strategy and doctrine.

Coercive Influence and Persuasive Influence -- The Transition

Coercive strategies are but one dimension of military power's ability to influence. It is the dimension of force application. As nations' capabilities and priorities evolve, strategies to affect them must evolve as well. The Third Wave of global powers, according to the Tofflers, will be dominated by those nations capable of rapid management of information. Inherent is advanced technology, superb education, financial expertise, computing capabilities, a proliferation of services, etc.

Third Wave nations will control the global flow of information, thereby subordinating all Second Wave and First Wave civilizations. However, due to global linkages of all nations, poorer nations will retain the ability to adversely affect Third Wave nations. Therefore, tensions between the Third Wave civilizations and the older two forms of civilization will continue to rise, and the new civilization will fight to establish global hegemony, just as Second Wave modernizers did with respect to the First Wave premodern societies in centuries past.[9]

As the world experiences these changes, and the Cold War paradigm of global restraint secedes into outbreaks of regional conflict among nations of varying "Waves," these conflicts will be of differing nature as compared to centuries past. Third Wave force will be earmarked not only by coercive capability, but a new form of influence will become politically and militarily viable -- persuasive influence.

Persuasive Influence

Persuasively influencing an entity connotes the use of armed force for reasons other than direct destruction. Stephen J. Cimbala, a professor of political science at Pennsylvania State University, has written on this subject and he notes four types of "noncoercive persuasion" applicable to armed forces. These include civic action, trip wire functions, military demonstrations and military diplomacy. He writes:

> In each category there are borderline behaviors which, one might reasonably argue, partake of coercive and noncoercive influence. I suggest nevertheless that each of these four categories has a center of gravity that is closer to noncoercive than to coercive persuasion. In coercive persuasion, the threat to use force is manifest or apparent, and often involves the credible threat to escalate a crisis or war to a more dangerous or destructive level. Coercive persuasion is more like Schelling's compellance than deterrence: it is a more active than passive form of persuasion, and the threat of military action looms in the foreground, not background. President Kennedy's quarantine of Soviet military shipments to Cuba in October 1962 was an act of compellance, with the objective of forcing Kruschev to remove the missiles, as well as deterrence, precluding other missiles from being shipped to Cuba." [10]

These persuasive actions are applicable across the spectrum of conflict. Though most seem to apply best to low intensity, insurrectional types of conflict, all forms of influence have possible applicability in any crisis. The duty of the strategist is to figure the optimum fit of the means of influence to desired ends.

Civic action denotes a wide array of activities for armed forces participation. Efforts are centered on helping communities, regions, and nations to support human needs. Capabilities of groups such as Seabees and the Army Corps of Engineers in such actions are obvious. Spacepower can also contribute, both in concert with ground forces and by themselves.

Space assets can be used as a civic action tool to monitor weather and environmental changes that affect a region's crops, forestation, rivers and lakes, animal migration and other natural resources. Space-based communications capabilities can be introduced to previously denied areas, to improve existing infrastructure, or in response to an emergency. Space-based navigation capabilities can be offered to allow access to remote areas and to assist in national emergencies.

Cimbala's second type of "noncoercive persuasion," the trip wire concept, involves putting a force into an area to monitor two adversaries in an attempt to defuse hostilities between the two. US efforts in the Sinai reflect such a concept in practice. To date, this has involved putting neutral countries' military forces in harm's way. Many lives have been lost, and plenty of national treasure has been spent on such operations.

Today's actual, as well as technologically feasible, space assets can be employed in such operations without regard to human and monetary risk. For example, actual space forces can monitor each sides' communications, force movements, industrial output and fiscal spending (to negate belligerent's ability to move to a "war footing"), while technologically feasible forces could enforce no-movement zones. In other words, the trip wire concept would change from a third party risk-oriented paradigm to the adversaries' managing their own risk. Without today's technologically feasible space force, however, space forces can only contribute to the old paradigm by supplying third parties with information concerning the adversaries.

Cimbala's third type of persuasion, military demonstration, involves strategically timed and tailored activities to demonstrate national capabilities in an effort to stave off aggression by an adversary. Such actions have been known as "showing the flag." Again, in the past this has required putting national assets at risk.

Spacepower can achieve the same ends without this risk. It can demonstrate national capabilities to surveil and respond. Possible actions include demonstrating to the world *writ large* what a possible adversary "has up its sleeve," in an effort to sway world public opinion and condemnation. Today's actual space assets can possibly demonstrate capabilities to accomplish such things as disrupt terrestrial activities of an adversary, such as electric production and distribution, financial data transfer, communication, etc. It can also demonstrate its ability to disrupt an adversary's space activities, like a momentary, "unexplained," "hiccup" of an adversary satellite and/or its capabilities. Spacepower capabilities can be used creatively. Tracking of adversary leadership, for example, can go a long way in demonstrating an ability and intent to target leadership.

Cimbala's final type of noncoercive persuasion, military diplomacy, involves the spectrum of United Nations-type actions involved in peace making, peace keeping, and peace enforcement. As in the other forms of persuasive influence, the past has required the risking of third nation troops and resources to accomplish the mission.

Spacepower can bring many unique capabilities to bear on this problem, as well. Assets can be used for assessment of belligerents' activities through surveillance, environmental monitoring, personnel tracking, etc. Human assistance can be rendered through timely and accurate delivery of relief supplies. Counterdrug portions of these missions can be carried out through surveillance and tracking by today's actual space forces. Today's technologically feasible space forces could provide terrestrial air and sea control. Elections can be protected from the political ramifications of corruption by direct satellite communication links of ballot boxes, thereby negating the need for hand tallying by people of questionable loyalty. Though not all communication systems are foolproof, they certainly have less political corruption potential than people do.

In all, today's actual space forces offer some limited advantages over terrestrial forces in some aspects of presence and influence. More presence advantages seem to exist vice influence advantages due to current political limitations associated with space force application. Current space force technological capabilities could remedy such limitations if they were fielded. Since they are not, we must look toward future advancements, based on directed needs, to enable spacepower capabilities in this area. The question becomes "What could future combat entail?" "How could it be fought ?"

Presence and Influence Effects in Future Combat

With all of this said then, what will future conflicts look like, and how can spacepower be integrated into the application of military capabilities to achieve national objectives? Regardless of the adversary's stature, or on what "wave" it is surfing, the battle will be joined for domination of the temporal plane.[11]

The ability to act, in a timely manner, based on proper perceptions of an adversary's intent and capabilities will be the hallmark improvement in US capability in future warfare. Information is the mere existence of data, but knowledge is the useful application of such information. Therefore, the information collected by various resources is merely interesting; the knowledge generated by such information is power. "Knowledge warfare," or the capability to manage knowledge -- friendly, enemy, as well as third party -- will supplant what is now known as "information warfare" and "command and control warfare" as the human experience continues.

Knowledge will be wielded as power, but not with impunity. Knowledge warfare will be employed as a common mission element, and will be orchestrated at the strategic, operational and tactical levels of war. Knowledge warfare will be used in peacetime in order to prepare for the next conflict, as well as influence non-adversarial entities.

Knowledge warfare consists of both offensive and defensive elements. Offensively, US forces will seek to "capture" an enemy's cognitive process and extend its OODA loop.[12] Defensively, preserving friendly "total" reality is the goal. That is, we must protect our ability to collect and interpret good, uncorrupted information. As technology advances allow, knowledge warfare will be increasingly engaged in, therefore one's vulnerability to it will become one's Achilles Heel.

These futuristic visions of influence are made possible through spacepower's ability to be present. However, how can spacepower's ability to project presence and influence be proven? Without an existing fully functional space architecture, no deductive evidence exists. Therefore, one must induce this capability from related action.

Public and governmental reactions to *Sputnik*, coupled with the race to limit military capabilities in space through treaties, protocols and conventions, along with world-wide public discord on SDI and current space weaponization trends, seem to inductively prove spacepower's capability to influence. Note, as said before, today's spacepower ability to directly influence is limited. However, this discussion seeks to demonstrate that even with today's limited capabilities, spacepower wields a certain amount of worldwide influence -- with an eye to the massive influence potential of fully functional spacepower.

Historical Analysis of Spacepower's Ability to Influence

US Reaction to Sputnik

Much of this discussion is based on research done by Peter L. Hays.[13] In his doctoral work, Hays analyzed major developments related to US military space doctrine and how the launch of Sputnik I and II affected it.

The Soviet Union became the first nation to access space when it launched *Sputnik I* on 4 October 1957. The Soviets rapidly shocked the world again when it launched a live animal, Laika the dog, on *Sputnik II* the next month. Though both satellites had no direct military application, and neither were much more than pieces of metal in space, the fact they were in space impacted US, as well as the world's, consciousness. The US' concept of itself as world leaders in technology, as well as its concept of national security, was shattered by the Soviets quick leg up in space-faring. Not missed by Americans, and the world, was the fact the Soviet Union now had new ways to deliver the dreaded nuclear weapons that had been playing on the world's psyche since the end of World War II.

Two years prior to *Sputnik I*'s launch, the National Security Council (NSC) warned of the public impact of the first satellite launch in NSC 5520. Though many public statements were made about pending satellite launches for the International Geophysical Year (IGY), neither the Eisenhower administration nor the American public were fully prepared for the beginning of the space age. Hays writes:

> The public reaction to the *Sputniks* and the political reaction to the shock of the American public fundamentally shaped US space policy for several years at least. The pervasive atmosphere of uncertainty and panic that developed after the *Sputniks* rocketed US space efforts to the top of the political agenda and meant that these efforts would command almost unlimited attention and support. For the Services, this meant that space was no longer a strategic backwater and the concern only of true believers but was now apparently a clear pathway to increased power and prestige. The uncertain security implications of the *Sputniks* in the minds of the public, and the desire on the part of all the defense organizations and sectors (which had been slighted by the New Look to make up for the years the locust had been eaten), combined to create an atmosphere conducive to increased defense spending and a thorough examination of the security potential of space.[14]

Many reasons can be given for this public reaction. Poor planning and public relations on the part of the administration prior to the launch can be partially blamed, as well as the development of the power of the media. Through the all-important power of selection, the *Sputniks* were kept in the headlines in what devolved into a media feeding frenzy on US spacepower inferiority during late 1957 and into early 1958.[15] Hays notes the Eisenhower administration's initial public relations efforts were disjointed and presented a crisis atmosphere in which security implications of the opening of the space age were emphasized.

Regardless of the reasons, and there were many, the facts support the notion of a concerned public in the wake of the first launch of an orbital object. People and governments were, for the first time, *influenced* by the *presence* of a man-made spacecraft. Even though most could not physically deduce the object even existed, they were influenced by its existence and the notion another nation now "owned" the high ground. *Sputnik I and II* changed the way the world looked at itself for all time. The question could be asked, "Why were these events different from past technological breakthroughs, such as the nuclear weapon, the first tank, the first iron-clad, or steamship?"

The answer seems to lie in the fact that a new medium was being exploited. A medium which encompassed all the other warfighting media, and from which they could all be theoretically affected. Space was a medium whose characteristics offered many advantages -- geographical coverage, sustainability, speed, and stealth. Some of the other innovations previously mentioned offered many of the same advantages in their day. However, none of them offered such advantages in quite the global manner as space.

World Wide Space Treaties

Does spacepower really "influence" anyone? An analysis of the answer to this question must be inductive vice deductive. Since a fully functional spacepower capability does not yet exist, there is no direct evidence with which to deduce its ability to influence through presence. Therefore, this analysis will infer spacepower's ability to influence via inductive reasoning.

The most striking inductive evidence of spacepower's ability to influence is via a review of political reaction to spacepower's real and perceived capabilities. Most notable examples of these include political reactions to limit spacepower advances, as well as recent public reactions of China and Russia to perceived US spacepower capabilities -- both present and potential.

The influence generated by the presence of space assets has resulted in treaties, restricting certain activities in and from space. Interestingly, most of the restricted activities have been beyond the technical abilities of spacefaring nations at the time the treaties were drafted. To cite each treaty in its entirety is beyond the scope of this thesis. However, factors relevant to the impact of spacepower's influence will be discussed as they appear in the treaties.

The "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies," otherwise known as the "Outer Space Treaty," was signed in Washington, London and Moscow on January 27, 1967, and was ratified by all parties on October 10, 1967.[16] This treaty calls for, among other things, prohibiting the following:

a. Appropriating by means of sovereignty, use or occupation, or any other means, of any portion of outer space to include the moon and celestial bodies.

b. Threatening or using force against the territorial integrity and political independence of another state.

c. Placing in earth orbit, installing on celestial bodies, or stationing in space in any other manner, weapons of mass destruction (generally defined as nuclear, biological or chemical).

d. Building military bases, installations, or fortifications on the moon or other celestial bodies.

e. Testing weapons of any kind on the moon or other celestial bodies.

f. Conducting military maneuvers on the moon or other celestial bodies.

g. Initiating activities that could cause harmful interference with the activities of other states without first consulting with those states.

h. Causing harmful contamination of the moon or other celestial bodies.

The "Treaty on the Limitation of Anti-Ballistic Missile Systems" was signed by the US and the USSR in Moscow on May 26, 1972, and was ratified on October 3, 1972.[17] It is important to note that many in Congress today are calling for either its modification or abrogation to allow the US to field a viable National Missile Defense (NMD). In yet another inductive example of spacepower's ability to influence, there is loud and unambiguous dissatisfaction being expressed by other world powers, with China and Russia topping the list. Among other things, this treaty restricts the following:

a. Developing, testing or deploying space-based anti-ballistic missile (ABM) systems or components, such as missiles, launchers, or radars.

b. Interfering with parties' national technical means of verification provided such systems are operating in accordance with generally recognized principles of international law and are in fact being used to verify provisions of the ABM Treaty, Strategic Arms Limitations Talks (SALT) I, the Thresholds Test Ban Treaty, and the Peaceful Nuclear Explosions Treaty (should the latter two treaties be ratified by the US Senate).

The "Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques," was signed in Geneva, Switzerland on May 18, 1977, and was put into force January 17, 1980.[18] This document calls for prohibiting the use of environmental modification techniques to destroy, damage or injure another state.

The "Convention on Registration of Objects Launched into Outer Space" was signed in New York on January 14, 1975 and was put into force September 15, 1976.[19] It calls for penalties for nations failing to notify the United Nations Secretary General of the launch of a space object.

The "Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War Between the United States of America and The Union of Soviet Socialist Republics" was signed in Washington on September 30, 1971, and was entered into force the same day.[20] It warns against the failure to notify the parties immediately of detection of unidentified objects by missile warning systems, or of interference with those systems or with related communications systems, if such occurrences could create a risk of outbreak of nuclear war between the US and USSR.

Other treaties, protocols and conventions have provisions that impact space operations. These include:

a. In 1963, the "Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Underwater."

b. In 1968, the "Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space."

c. In 1972, the "Convention on the International Liability for Damage Caused by Space Objects."

d. In 1973, the "International Telecommunications Convention."

e. In 1976, the "Convention on Registration of Objects Launched into Outer Space."

f. In 1979, the "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies."

g. In 1972, the "Memorandum of Understanding Regarding the Establishment of a Standing Consultative Commission."

Strategic Defense Initiative Discourse

The SDI debate grew directly out of the ABM debates of the early 1970s. Mutually Assured Destruction (MAD) was a cornerstone on which ABM was based. Many critics of ABM objected to this framework and began studying a defense-reliant deterrent capability. The Reagan administration became the heralder of this approach and the debate began in earnest with President Reagan's "Star Wars Speech" of March 1983.

The moral argument of deterrence through MAD versus actively defending the nation became the core of public debate. Reagan's March 1983 speech said it clearly; "What if free people could live secure in the knowledge that their security did not rest upon the threat of instant retaliation to deter Soviet attack?"[21] In other words, rather than relying on the morally repugnant option of nuclear retaliation, the MAD bulwark, the US could now actively defend itself.

Of course, the moral argument was met unenthusiastically by proponents of MAD -- as Simon P. Worden says, "a tribute to its effectiveness." James Schlesinger wrote, "Cries of the immorality of deterrence are both premature and pernicious."[22] Robert McNamara wrote, "Until there are inventions that have not even been imagined, a defense robust and cheap enough to replace deterrence will remain a pipe dream. Emotional appeals that defense is morally superior to deterrence are therefore 'pernicious.'"[23]

Beyond the moral argument was the question of the effectiveness of space as a medium for defensive operations. Defensive operations require the ability to operate within most, if not all, of the battlespace. Using a World War II example, the Maginot Line was a singular defensive position easily circumvented, and therefore operationally useless. On the other hand, Britain's defensive posture was multilayered and very effective. The first layer was the British force in France, the second was the British fleet in the English Channel, the third was the Royal Air Force, and the final layer were the shore defenses and Home Guard.[24] The Germans had an easy go of it as they went around the former, and a much more difficult time dealing with the latter.

If the defense can operate throughout the battlespace, it is effective. Early missile defense systems were terrestrially based and designed for terminal intercept and therefore gave up most of the battlespace to incoming missiles. The ability to operate in space, over the entire battlespace, gave defense the optimal position and made SDI theoretically, as well as technologically, possible. Thus, space operations became the key to effective defenses.[25]

Worden sums up the impact operating from space had on the SDI debate:

> Against the compelling strategic realities of space, SDI critics raised two objections. First, they charged that space defenses would be vulnerable and could be cheaply negated. This argument is not supported by technical facts. Second, following Soviet propaganda, some SDI critics worried over the "militarization" of space. This charge ignores the fact that it was the ICBM that not only militarized space but nuclearized it as well. When the first German V-2 broke through the edges of space, that medium was forever broached. In addition to raising the possibility of attack through space, ICBMs have also been the basis of launch vehicles since the 1950s. In the 1980s, sixty percent of long haul military communications [went] through space systems and most surveillance is space-based. Space has long since been militarized; it is not SDI that raises this problem.[26]

National Missile Defense Discourse

While these treaties illustrate a historical reaction to real and assumed spacepower capabilities -- and provide evidence of its ability to influence nations -- there are even more recent examples of world governments' strong reactions to perceived advancing US spacepower. Most notably, both China and Russia have recently backed pacts to ban space weapons.

According to *Reuters*, on 10 February 2000:

> China, on Thursday, formally proposed negotiations to conclude a global treaty that would ban the testing, deployment and use of weapons in outer space. Russia's Ambassador Vasily Sidorov immediately took the floor at the Conference on Disarmament to back the proposal by China's envoy Hu Xiaodi. Both China and Russia have denounced recent US missile tests and argue that a proposed US national defense system would violate the landmark Anti-Ballistic Missile (ABM) Treaty….Hu said negotiations on preventing an arms race in outer space should be "one of the highest priorities" on the agenda of the United Nations forum…."The negotiation and conclusion of an international legal instrument or instruments on the prevention of the weaponization of and an arms race in outer space should be set as the definite direction and ultimate goal of the work of the committee.[27]

Some provisions of the aforementioned treaties, protocols and conventions seem to limit the applicability of this thesis. Such restrictive agreements could negate the possibility of fully exploiting spacepower. However, to the contrary, the existence of such agreements demonstrates the applicability of a fully capable space force. The existence of these agreements seem to prove the efficacy of spacepower, much like the 1930s discourse on air warfare owed its existence to airpower's efficacy.

These agreements were all ratified by the US with the restriction that they applied only in peacetime, and continued application of treaties during crises or wartime is dependent upon their nature, terms, or subject matter. The US position has been that it would have the right to determine the extent to which it would consider itself bound by specific terms in question.[28] Regarding the development of capabilities not specifically addressed in such agreements, it is a fundamental principle of international law that if an act is not specifically prohibited, then that act is permitted.[29]

There has been plenty of diplomatic activity regarding space operations, including those operations beyond the realm of yesterday's and today's technology. Diplomats have attempted to restrict many operations in and from space to curtail any destabilizing influence such activity might entail. The use of space for military or political purposes has been, and continues to be, a ripe field for debate. It seems the amount of such debate is primarily due to the concern people have for control of the perceived "high ground."

Conclusion

Aerospace power is expeditionary by nature. Given advanced spacepower capabilities to project power over vast differences in near real time, the concept of expeditionary aerospace power is expanded beyond the bounds of today's concepts.

As well as denoting being "alert to circumstances," and "readily available," presence involves a *perception* by an adversary that force is "close at hand." Military forces all can exert presence, some in more substantial ways than others can.

Three requirements exist for presence to be achieved. First, a force must be close enough, within its operating medium, to affect the adversary. Second, the force must have the resources and ability to physically affect appropriate targets within the adversary's system. Third, the force must be able to remain in an operationally significant position to affect an adversary.

Though the existence of real versus virtual presence is transparent to the adversary, it is a planning consideration for US policy makers. Real presence connotes the actual existence of forces capable of acting to influence an adversary. Virtual presence connotes the presence effect through the essence of an existing ability. It does not imply bluffing to realize the presence effect. In fact, virtual presence can be challenged, requiring demonstration of real presence to convince. Due to many circumstances, the latter version of presence seems most applicable to spacepower. Presence allows influence, and influence can be coercive or persuasive in nature.

Coercion is often treated as an end in itself, when it is actually the means to an end. The end is the desired result of coercion (or persuasion). Said another way, "Its not the bombing stupid, its the effect of the bombing!"[30] Unless the end is one that can reasonably be expected from coercive means, coercion may not be the proper or correct means. Generally, when we focus on the coercive uses of force, we tend to exclude the non-coercive aspects of this same force.

As warfare and technology changes, these latter aspects of force may become more viable than coercion ever was. Until then, however, if we continue to regard coercive influence as the military's *sine qua non,* we will reach wrong, or at least incomplete, conclusions regarding means with which to reach ends.

The world is changing. Ways with which to influence other entities are changing. The day may come when persuasive influence results in greater strategic effect than coercive influence does. Killing people and breaking things, while still maybe applicable when fighting First Wave civilizations, may be discarded for the greater political and military value of persuasively influencing other nations.

Regardless of when and if this day arrives, it is imperative that both forms of influence are factored into strategic political and military decisions to ensure complete capability. In other words, the question is not always, "What are the physical effects sought?" but rather "What are the mental changes -- the transformation of will -- we seek to introduce?" The answer to this question lies in the consideration of both types of influence.

To deductively "prove" spacepower can influence through its ability to project presence is impossible due to lack of direct historical evidence. Direct evidence is lacking because spacepower, as an integrated, fully functional system, does not yet exist. Hence, this chapter inductively analyzes spacepower's capability to influence without direct evidence, through inferential evidence supplied by diplomatic discourse.

The shock of diplomatic and public reaction to the launch of both *Sputniks* demonstrated that for the first time, and for all time after, national security decisions and agreements between nations would be affected by man's ability to access space. As *Sputnik* gave way to the worldwide space race, treaties, protocols and conventions have restricted operations in and from space.[31]

The SDI debate, as well as the current NMD debates, have been the most recent robust arguments regarding space capabilities and were a direct result of former ABM debates. The SDI debate brought to the fore the defensive utility concept of space, as an ability to operate over the entire battlespace, thereby presenting defensive opportunities throughout the offensive systems' envelopes. Critics of this debate raved of the "militarization" of space, as if SDI was not a reaction to current offensive systems that transit space, and future systems that could exist in space.

Such discourse seems to be a result of people's reaction to ability of a nation to access and operate from space, regardless of current technical capabilities. Hence, influence seems to be generated by space assets, through virtual, as well as real presence. The USAF's *New World Vistas* study says it best (if a little overzealously):

> (Space assets) present a presence over battle areas that is difficult to deny, and do so repeatedly and frequently enough from LEO, or continuously from GEO, so that force application using them could have a marked strategic as well as tactical effectiveness on

the conduct and outcome of conflicts. This force can be applied anywhere rapidly, with minimal risk to US forces, and at all levels of conflict. It is equivalent to artillery and strike support with infinite range and moving at 25,000 mph, with the added advantage of enjoying complete surprise.[32]

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[1] William Mitchell. *Winged Defense*. (New York: Dover Publications. 1988), 26.
[2] David E. Lupton, Lt Col, USAF (ret). On Space Warfare: A Space Power Doctrine. (Maxwell AFB, Alabama: Air University Press. June 1988), 19.
[3] Ibid., 19.
[4] Ibid., 19.
[5] See *New World Vistas: Air and Space Power for the 21st Century,* for an in-depth discussion of technologically feasible space force application and control technologies. In the case of high energy lasers, the study reports on page 86 of the space applications volume :

> High-energy laser weapons have been thoroughly analyzed and much laboratory work was done under the SDIO/BMDO program, however, no such system has been fielded. This is for a number of reasons, some obviously political, but not a small factor is the high cost, large weight, and relatively few shots available from such systems. These weapons will become much more attractive in the future as a result of new technologies such as 20+ meter thin film mirrors and other techniques…new technology phase conjugation correctors, shorter wavelengths, more accurate pointing and tracking techniques, etc. In addition, they will greatly benefit from the expected major lowering in the cost of access to space.

[6] Department of the Air Force. *Global Presence 1995.* (Washington: Government Printing Office, 1995): 5 - 7.
[7] This is even truer now that DoD ephemeris data has been removed from publicly accessible internet pages.
[8] Alvin and Heidi Toffler. *War and Anti-War: Survival at the Dawn of the Twenty-first Century.* (Boston: Little, Brown and Company, 1993) 21
[9] Ibid. 23.
[10] Stephen J. Cimbala. *Military Persuasion: Deterrence and Provocation in Crisis and War.* (Penn: Penn State Press. 1994). "Military Persuasion and the American Way of War." *Strategic Review*. (Fall 1994): 33 - 43.
[11] Much of the discussion in this section deals with material gleaned from the "Reinvention of Space" briefing written by future thinkers at the Space Warfare Center. The author gratefully acknowledges the counsel of Lt Col Mike Kaufhold, SWC/XP (Winter 1994).
[12] The Observe-Orient-Decide-Act (OODA) Loop is a creation of Colonel John R. Boyd, USAF, retired. It is a systems look at the decision making process, which explains the implementation of an action based on the observation of another action, an interpretation of its implications, a decision as to a reaction, and finally implementing the (re)action itself. The object of war, therefore, is to extend your enemy's loop, while shortening your own.
[13] Hay's doctoral dissertation from the Fletcher School of Law and Diplomacy, "Struggling Towards Space Doctrine: US Military Space Plans, Programs, and Perspectives During the Cold War."
[14] Peter L. Hays. "Struggling Towards Space Doctrine: US Military Space Plans, Programs, and Perspectives During the Cold War." A doctoral dissertation presented to the Fletcher School of Law and Diplomacy. May 1994. 103 - 104.
[15] Ibid., 105.
[16] Collins. *Military Space Power: The Next Fifty Years*. 173.
[17] Dana J. Johnson, "The Evolution of US Military Space Doctrine: Precedents, Prospects and Challenges." A doctoral dissertation presented to the University of Southern California. December 1987. 39.
[18] Ibid., 340.
[19] Ibid., 339.
[20] Ibid., 339.
[21] Simon P. Worden, *SDI and the Alternatives*. (Washington: National Defense University Press. 1991), 115 - 116.
[22] Ibid., 116.
[23] Ibid., 116 -117.
[24] Ibid., 115.
[25] Ibid., 115.
[26] Ibid., 115.
[27] "China and Russia Back Pact to Ban Space Weapons." *Reuters*, 10 February 2000.

[28] Ibid., 336.

[29] Curtis D. Cochran, Dennis M. Gorman, and Joseph D. Dumoulin, eds. *AU-18: Space Handbook*. (Maxwell AFB, Alabama: Air University Press. January 1985), 15-4.

[30] This discussion of end versus means is a result of the author's discourse with Col Richard Szafranski of the Air War College, and many of these ideas stem from those sessions.

[31] In his *Aviation Week and Space Technology* article "Military Space Operations and Organization -- Some Thoughts About the Future," General Ashy takes a realist view of worldwide space treaties. "There are international protocols which address [the use of space], and for example, weapons of mass destruction are prohibited. There is overarching agreement however, that the nations of the world community may go into space and operate freely due regard without sovereignty being claimed or exercised by any other. Conversely, it is accepted internationally that sovereign nations of the world possess the sovereignty of their respective air, territorial seas and land areas. On the other hand, nations may freely sail "due regard" on the high seas with no other entity claiming sovereignty. Herein lies a key lesson. There has been conflict on and ver the high seas when vital national interests have been threatened, and I suggest that inevitably similar situations will occur in space -- when our valuable assets will be threatened to the point we must protect them. Like the high seas protocols, the freedom of nations to go into space and operate outside of any sovereign domain should and can be preserved. We should also be prepared for the possibility of future threatening eventualities."

[32] *NWV*, "Force Projection From Space," Ivan Beckey.

Chapter Five

Modeling and Synthesis

The United States should take immediate action to provide a capability to exploit space and protect our national interests ... look to space and pray.
-- James Canan, War in Space

Overview:

This chapter synthesizes the three main concepts presented in Part I of this thesis: spacepower characteristics, its ability to project presence, and through presence, its ability to influence. Synthesis of these ideas is achieved by modeling thesis concepts and demonstrating how spacepower can be employed in a notional "real world" scenario to achieve political, as well as military objectives.

The scenario involves a conflict with the fictional third world nation of Aqan. It evolves from a political contest of wills into an economic warfare scenario. The applicability of spacepower is demonstrated as three options are discussed offering ways of conducting operations against Aqan.

This scenario is used to demonstrate the range and breadth of options a fully functional and integrated spacepower capability offers. It demonstrates how spacepower can efficiently be used on an escalating continuum of military power application. The advantages of spacepower are demonstrated throughout this discussion.

This scenario is not presented in an attempt to denigrate the applicability of terrestrial forces. Obviously, many more scenarios could be chosen that demonstrate the effectiveness of other forms of military power. As previously noted, all forms of military power are generally best employed in concert with one another. However, this scenario is used to demonstrate the innovative possibilities spacepower offers.

The Model:

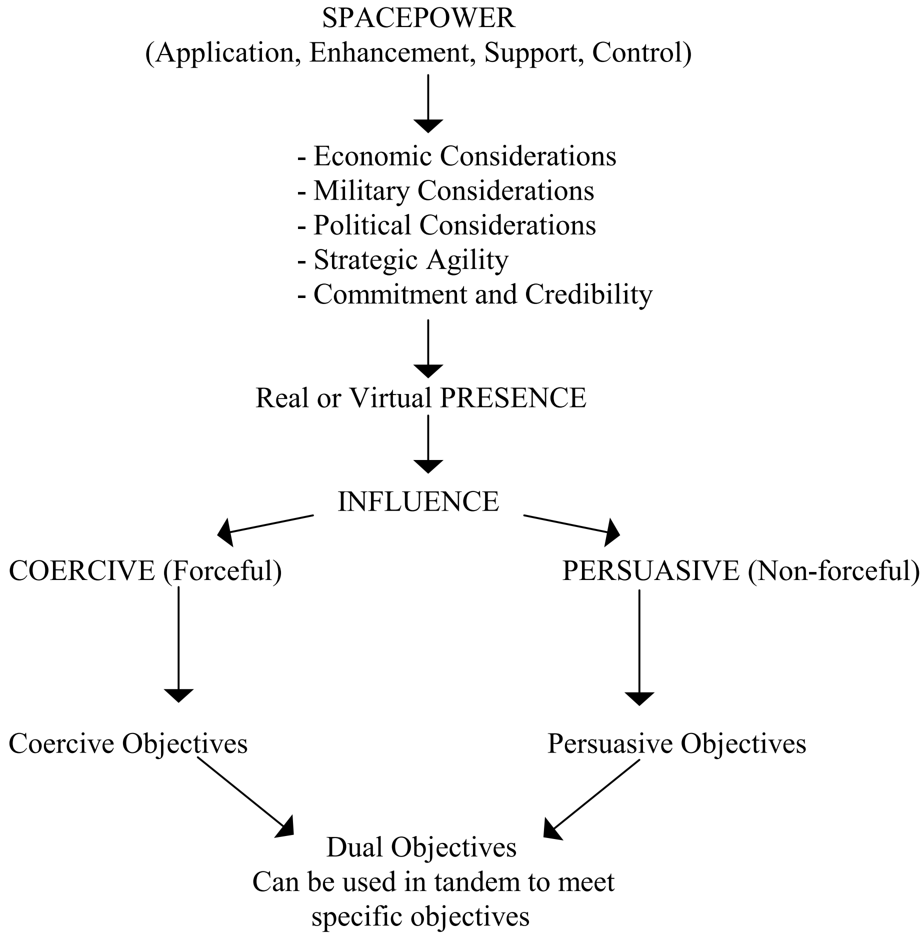

Figure One: Thesis Model

The model explains spacepower's effectiveness given a fully integrated and functional military space architecture, i.e. all four functional missions of enhancement, support, control and application can be achieved. Because operational spacepower is economically, militarily and politically viable it is politically flexible. In other words, decision-makers are more apt to employ force if they can be reasonably assured it will be effective and relatively risk free -- and adversaries are more apt to believe it will be used for exactly the same reasons.

Because of spacepower's physical characteristics, as well as its political flexibility, decision-makers would be more apt to use it. As the chance it would be used increases, spacepower's ability to be present is increased. This presence begets influence. Influence, then, comes with the adversary's perception of US ability and intent to use spacepower. The adversary, due to its perception of spacepower's presence, can be influenced. This influence can be coercive or persuasive, or both. In other words, US decision-makers can use forceful measures, non-forceful measures, or a combination to obtain desired changes in adversary action -- all with decreased regard for loss of US lives and treasure.

Assumed Scenario and Objectives:

The Islamic Republic of Aqan is destabilizing former southern USSR republics by training and equipping Muslim radical elements in the region. Local nations are incapable of arresting the situation, and have requested help from the US.

US objectives are clear. *Terminate the training and equipping of radical Muslim elements in the region by Aqan with the least amount of diplomatic and military risk possible.* Three options are available with escalating possibilities of negative diplomatic and economic impact and demand on US military resources. With each option, the US must clearly communicate desired objectives and possible ramifications to Aqan's government. While the impact of different economic warfare strategies on target countries can be widely applied and felt, this discussion considers affecting Aqan with minimum impact on third party nations.

Aqan's Economy

Using the descriptive economic hierarchy for country compartmentalizing offered at the USAF's School of Advanced Airpower Studies (SAAS), Aqan fits neatly in no definitive category.[1] Judging by certain economic factors, it lies somewhere between a commodity-based economy (CBE), and an industrial-based economy (IBE). Aqan's CBE characteristics include its high percentage of agricultural labor (36 percent)[2], 19 percent of its gross domestic product (GDP) in agriculture, its large export of basic minerals (99 percent of all Aqanian export is oil and associated fuel products), and imports of processed mineral products. Aqan's IBE characteristics include its high percentage of industrial labor (33 percent), and 31 percent of its GDP attributable to industrial capability. Both sectors are growing, commodity at about 5 percent per year and industrial at about 3 percent.

Its major trading partners and outside investors are Germany and Japan, with various other industrialized nations playing lesser roles. Even with a trade surplus of $4 billion in 1993, Aqan's external debt is growing. Long-term debt grew $13 billion in 1993, while short term debt grew $7 billion. Its debt interest runs at 100 percent of its total export revenue. The country is unable to currently pay over $28 billion in debt.

From March to November 1994, inflation in food prices rose 4000 percent. This, coupled with a high population growth rate and unemployment, has led to social unrest that has manifested itself in protests against government policies of economic liberalization. The *mostazafin*, or oppressed poor, have yet to see their expectations of a more prosperous life realized in spite of their sacrifices for the Revolution and the most recent regional conflict.

Instrumental facts in the discussion of differing strategies include all of the previous information plus:

a. Aqan imports nearly all of its oil production and transportation equipment from major US trading partners.

b. Virtually every Aqanian line of communication (road, railroad, and ports) is optimized to transport oil.

c. Aqan is attempting to acquire technology to locate oil reserves more efficiently.

d. The US has already partially isolated Aqan through sanctioning high technology products and embargoing oil. These measures have been general in nature to counter broad Aqanian desires to increase its military infrastructure, and finance international terrorist actions.

Economic warfare is not waged without costs to all nations involved, the “sender” nation, the targeted nation, as well as any involved third party nations. Each nation also experiences certain payoffs. The values realized by all involved countries associated with both of these concepts varies depending upon the strategy chosen, the economic sector(s) targeted, the status of the economy of any nation, and many other factors. This discussion addresses costs and payoffs as it presents each option.

Each option is discussed by illustrating certain themes. First, the economy’s targeted sector is examined. Next, the mechanism for realizing success is discussed. Measures of merit are presented to determine each option’s effectiveness. Next, implications of coercive and supportive measures are examined and discussed as they apply to the use of spacepower. Lastly, alternative options are presented.

Option One: Sanction

The targeted sectors of Aqan’s economy include trade and finance. The objective is to stop the flow of vital machinery replacement parts to service Aqanian oil production and transport equipment. This must be done through multilateral agreements with European nations whose economies are extremely dependent upon US markets. Sanctioning of these products will cause the following mechanisms to occur (unless and until the Aqanian government stops supporting Moslem radicals in the former USSR southern Republics):

a. Exports of oil will decrease, decreasing export dollars.

b. The debt will not be serviced as effectively without this revenue.

c. Inflation will rise.

d. Political instability will rise, which will adversely impact inflation even more. Additional and more supportive measures can be taken as well, i.e. offering support for a vital interest to the Aqanian government in exchange for a favorable resolution. Specifically, the US can offer to help the Aqanian government with its on-going oil location project.

Measures of merit to evaluate the effectiveness of this option include both overt and covert means. Overtly, Aqan's oil production and transportation will be monitored for a decrease, though it is realized that this decrease will most probably not occur rapidly due to the action taken. Covertly, monitoring will take place to note decreases in the delivery of equipment and parts from European nations. If the government continues to support rebels in the southern republics (i.e. there is no rapid termination of the problem and sanctions have been in-place for awhile), the economy's condition will be monitored for rising inflation and civil unrest.

Military implications of this operation are specifically space-oriented and include influencing the target nation in both a coercive and persuasive manner (figure two). Coercive influence includes those aspects that lead to the threat of escalated military action. Persuasive influence includes those aspects that are non-threatening, even supportive, in nature.

Coercively, military satellites can be used to track shipping as it unloads materials to ensure compliance with restrictions by both Aqan and supplier nations -- and to herald harsh economic retribution policies and actions. They can also monitor oil production and transportation. Additionally, training and equipping of rebel forces can be monitored to ensure compliance with objectives. Information operations can adversely affect Aqanian communications and control capabilities -- from C2 nets, to computer nets, to sea, road and rail traffic control nets.

Persuasively, these same satellites can offer support to the Aqanian government's oil location program in exchange for the government's cutting off support to the rebels. They can monitor Aqanian territory and detect possible oil caches.

The use of space assets offers both overt and covert advantages. Overtly, space assets are useful for their capability to continually monitor the subject area, while gathering and transmitting valuable information. Such a capability can be demonstrated to the target government -- as well as the world's population and governments -- to illustrate US resolve, knowledge and capabilities. Covertly, the same capabilities can be used, without any nation's knowledge, to allow denial flexibility, if that is deemed politically desirable.

The primary objective of this option is to avoid armed conflict while attempting to influence a change in Aqan's conduct. Therefore, though some of the described mechanisms are coercive in nature, they are only so due to the *implied* threat of forceful reaction. If positive measures of merit, as described earlier, are not observed, one of three possible options exist:

a. Pressure Aqan's government with even greater sanctions and begin to pressure for greater embargoing of Aqan's oil, thereby affecting an even greater portion of the economy (which could have greater disadvantageous ramifications for US allies' economic interests).

b. Withdraw the sanction, thereby admitting political defeat.

c. Escalate the use of military force to blockade/quarantine the same resources from reaching Aqanian oil production/transportation facilities. This strategy will be considered next.

Outcome		Mechanism		Targets
			Observe shipping in/out (Coercive)	Economy
	Deny materials to manufacturers	←	Demonstrate knowledge (C)	Ports
Stop govt support of rebels			Observe factory in/out (C)	Pub. Opin.
				Shipping
←			Locate oil caches (Persuasive)	Factories
	Influence govt to deny rebels support	←		Govrnment

Figure Two: Sanctions/Embargo Diagram[3]

Option Two: Blockade/Quarantine

The targeted sectors for this option remain the same as for sanctions and embargoes. The basic objectives, mechanisms, targets and reasoning are identical, except the primary objective is no longer to avoid armed conflict. However, this option relies on the use of force to enforce restrictions described previously (figure three).

The concept of a blockade is not defined well in any military manual, though JP 3-00.1, Joint Doctrine for Contingency Operations, defines it as "*belligerent* operations to prevent vessels, land transport, and/or aircraft of all nations, neutral as well as enemy, from entering or exiting specified ports, airfields, or coastal/border areas belonging to, occupied by, or under the control of an enemy nation." Quarantine is the blockading of specific goods into and out of a country.

The bottom line is that *no* subject goods (replacement parts and machinery) are allowed to enter the country from *any* source, or are other subject goods (oil) allowed to depart the target country. While persuasive strategies may continue to play a role in quarantines/blockades, they become less apt to be influential due to the extremely coercive nature of the overall strategy. The use of force is explicit with blockades/quarantines, vice implicit as with sanctions/embargoes.

Measures of merit to evaluate the effectiveness of the quarantine include those associated with sanctions/embargoes, as well as the observed trend at attempts to "run the blockade" with contraband items. The terminal measure will continue to be the target economy and social condition.

Military implications of this option are more pronounced than with the former. This discussion posits a force application capability from space. Specifically, this discussion assumes a robust network of intelligence satellites, allowing continual coverage of several widely dispersed geographical locations of the earth, as well as a capability to apply force (either kinetic energy or directed energy weapons) from other satellites or from MSPs, SMVs, SOVs and CAVs. Military assets in this option are used in a coercive manner, as any attempt at persuasive strategies will most probably be ineffective considering the nature of quarantines/blockades.

These satellite networks are used to track the movement of alternative sources for Aqan's oil production and transportation machinery replacement parts and new equipment, as well as equipment transfer and training of the rebels. Specifically, known-source third party nations' and Aqan's oil production facilities, ports, airfields, and over-land routes, will be monitored to detect any attempts to violate the quarantine. Shipment loading, departures and enroute segments will be monitored continually. Once shipments are at sea, airborne out of third party airspace, or on over-land routes inside Aqan, warnings of impending attack will be issued. If the monitored shipment continues, it will be attacked and destroyed.

Though no US ships or land personnel will be deployed to demonstrate what has previously been known as *presence*, it will become obvious that US forces are *present* after the first ship, or aircraft, or road vehicle is destroyed from space. Whereas virtual presence was implied prior to force application, real presence becomes dominant afterwards.

As in the first operation, the use of space assets to conduct such operations offers many advantages when compared to using terrestrial forces. No US personnel are placed at risk, thereby decreasing the political risk and increasing the political initiative to conduct such operations. Unlike former quarantine attempts, operations will not require massive numbers of surface ships, airborne warning assets, and alert interceptors, thereby decreasing the US' economic risk, and again increasing the political initiative to conduct such operations. Vast amounts of US military assets will not need to be forward deployed, and basing, overflight, and seaway rights will not have to be negotiated -- with all of the political capital that entails.

Mahan’s fleet-in-being concept will be realized at minimum human and economic cost.[4] Space assets can constantly cover wide geographical areas, allowing direct observation, detection, destruction and documentation of quarantine violations.

Outcome		Mechanism			Targets
	Deny materials to manufctrs ←	Attack/sink vehicles ←	Warn of impending attack ←	Monitor for shipments: a. Loading b. Departures c. Enroute d. Arrival ←	3rd party and Aqan Ports Shipping Factories Airfields Ovrld rtes
Stop support of rebels by govt	Influence Govt to deny rebel spt ←	↓ Threat of inflation and civil unrest			

Figure Three: Blockade/Quarantine Diagram

Option Three: Direct Attack

Assuming the first two options have failed, little is left to do (notwithstanding a complete withdrawal from the situation [the implications of which remain the same as discussed earlier]), except to apply direct force to the problem. In effect, four economic sectors (finance, materials, industry, and trade) are targeted in this option, and one target set is most applicable -- the oil transportation system (figure four).

Because US objectives are limited (stop the supply and training of rebels) the concept of a full-scale attack on the entire economy, as could be done by simultaneously targeting power, industry, etc., is not applicable. The level of effect would far outweigh that desired. Oil production facilities will be spared to allow relatively rapid renewal of export capabilities on cessation of hostilities. By limiting disadvantageous effects to the majority of Aqanians, the US can demonstrate its benevolence, as well as its capability and willingness to use force if pressed to do so, thereby reinforcing the point for future economic warfare scenarios.

Conversely, directly attacking Aqan’s oil transportation targets will have a larger adverse impact on Aqan’s ability to export its largest percentage of high value resources. This will lessen

Aqan's capability to service its debt for a longer period, thereby increasing inflation (and adverse public sentiment toward the government) for a longer period. However, the effect is negligible when compared to the consequences of full-scale direct attacks on the Aqanian economy. Relatively rapid recovery after cessation of rebel support is possible and expected.

Measures of merit to evaluate the effectiveness of the direct attack are obvious. The inability of Aqan to transport oil will be demonstrated by production and delivery falling to near zero.

Military implications of this option resemble those of option two, though the extent of reach and coverage required will actually decrease due to limiting the operation to one target set located in one geographic region. Assuming the US ability to apply force directly from space, kinetic or directed energy weapons will be dropped, or fired, with enough accuracy to render Aqanian oil transportation system inoperable.

Vital areas of the system will be selected as DMPIs (Desired Mean Point of Impact) to mitigate the lasting effects of direct attack to allow for relatively rapid startup of oil transportation once Aqan's policy is changed. These assets can remain in orbit to continually put the transportation system at risk if Aqan were to continue its unacceptable policy. Military space assets will be used in a purely coercive manner, no attempt at persuasive operations will be made, nor is it appropriate with this option.

Space assets will also be used in this option to communicate with the Aqanian people by radio and television. US intentions will be clearly stated with reassuring gestures made about the limited extent and highly accurate nature of the attack. It is hoped this measure will suffice to dampen anti-American feelings, not only in Aqan, but in other Muslim countries, as well.

As in the first two options, the use of space assets to conduct such operations offers many advantages over the use of terrestrial forces. The risk to US military personnel involved in direct attack by terrestrial forces is even greater than in a blockade/quarantine scenario, therefore the use of space assets to conduct direct attack operations is that much more politically and morally advantageous. Attack operations generally require that much more people and equipment be forward deployed, increasing the drain on fiscal resources, increasing the political capital involved in negotiating basing, overflight, and seaway rights, and potentially increasing the US population's discontent with seeing their sons and daughters put in harm's way. The use of spacepower in this example mitigates much of this.

The cost in personnel, equipment and money involved with supporting such a terrestrial operation is of primary concern to a policy maker, whereas using space assets requires no more money than has been spent to originally put them on orbit (except to eventually replenish kinetic energy weapons; directed energy could be conceivably replenished on-board).

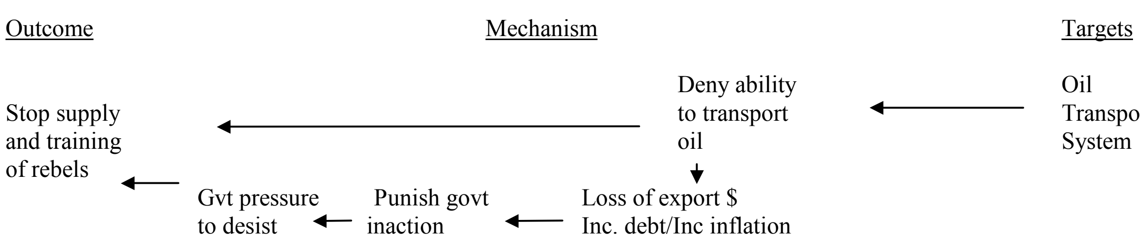

Figure Four: Direct Attack Diagram

Conclusion

Economic warfare can be conducted in many ways, bounding the range of depth and breadth with its application and effects. Generally speaking, as options expand the explicit threat or use of military force, the effects upon the target country are farther reaching and deeper felt. The same is true for the possibility of adverse impact on the "sender" country, as well as any third party involved state. The costs each nation realizes to conduct, participate in, or be targeted by economic warfare increase as the threat of force increases.

In this case study one situation is posited with three options presented for dealing with it. Political factors are introduced and held constant throughout the range of options, i.e. minimize adverse effects on the overall adversary economy. Reasons for this consideration include humanitarian and political concepts, as well as an understanding that world economies are intertwined, i.e. deeply negative impacts on Aqan's economy have far reaching effects.

The three options represent an increasing risk/impact continuum. Sanctions and embargoes are designed to avoid conflict while attempting to change the policy of the target country. An implicit threat of future escalation (which is the basis for the coercive acts undertaken) is inherent, especially when dealing with the US. This option also presents itself to using persuasive acts at the same time, if available. The second option increases both the risk to the US, or "sender," and the adverse affects experienced by the target, Aqan, while also increasing the costs to involved third party nations, e.g. Germany. As with the final option, all actions undertaken in this option are coercive in nature. The final option, direct attack, involves the greatest impact on both sender and target; though its use is an implicit admission no other options seem capable of success.

Military and political implications of all three options demonstrate the inherent usefulness of spacepower. Military assets employed from the medium hold many advantages over their terrestrial counterparts. Similar to what Douhet argued vis-à-vis airpower, political, economic, moral, and military risks are all dramatically decreased when humans and massive amounts of military hardware and machines are removed from the political and strategic decision process.

Bottom line: military efficiency and effectiveness, which drives political flexibility, is the "why" of the space dimension of aerospace power -- spacepower.

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[1] SAAS 650, Economics of War, discussed an economic hierarchical system comprised of three levels. The lowest economic level, a commodity based economy (CBE), generally deals in basic resources and raw materials. An industrial based economy (IBE) deals in finished products. The most advanced economy, a knowledge based economy (KBE), deals in information dissemination and services. Real world economies rarely fall neatly into one category or another, all are generally multifaceted.

[2] All economic statistics, either quantitative or qualitative, presented in this paper are representative of various third-world nations and were extracted from the 1994 version of the Europa Yearbook, Volume One.

[3] The strategy diagrams in this document are based on a strategic planning analysis technique taught at SAAS in 1994. It is based on the concept of targeting for desired results. From the desired results flow the mechanism to achieve them, and from these mechanisms flow the target sets. Inherent in this concept is nodal analysis, cultural perception, and other techniques for understanding adversary action/reaction.

[4] In his books, The Lessons of the War with Spain, The Interest of America in Sea Power, Present and Future, and The Major Operations of the Navies in the War of American Independence, Alfred T. Mahan, the great naval strategist posited the enormous potential of the fleet as it related to affecting an enemy's lines of communication, as well as the fiscal considerations of building and maintaining such a fleet. "It is indeed as a threat to communications that the fleet in being is chiefly formidable." "The fleet in being has a moral as well as physical affect." "Where will you strike your mean between number and size? You cannot have both, unless your purse is unlimited."

PART II: How Can Spacepower be Pursued?

The world that lies in store for us over the next 25 years will surely challenge our received wisdom about how to protect American interests and advance American values. In such an environment the United States needs a sure understanding of its objectives, and a coherent strategy to deal with both the dangers and the opportunities ahead.

-- Phase I Report of US Commission on National Security in the 21st Century

Chapter Six

A Unique Historical Opportunity

Now is the time to take longer strides - time for a great new American enterprise - time for this nation to take a clearly leading role in space achievement, which in many ways holds the key to our future on Earth.
-- John F. Kennedy

*Space for peaceful purposes - what a bunch of *!#%*!.# bull*.!% that was!*
-- General Bernard Schriever, USAF

The introduction of new military capabilities often involves a rethinking, a mental jump to entirely new concepts. It is not a question of doing something better, it is a question of doing something different. Not everyone can make this mental jump.
-- General Merrill McPeak, USAF

And now is the time to do it because we can afford to take risks today with the threats we have worldwide that we may not be able to take in the future. If we are not willing to take those risks today, we certainly will never take them when more relevant and large threats materialize in the years ahead. We've got to take advantage of this day and time.
-- General Howell Estes III, USAF

Overview:

Part I of this thesis demonstrated spacepower's potential as a fully functional arm of national military power. It answered the question, "Why is aggressive spacepower development worthwhile?" Part II analyzes how the U.S., and the USAF in particular, can realize the benefits of fully functional spacepower capabilities.

This chapter is a bridge between the two parts of this thesis. It discusses the unique historical opportunity the U.S. presently has to more aggressively pursue spacepower capabilities.

The U.S. stands at a unique historical crossroads regarding its capability to fully exploit space -- and control space. If it does not take this opportunity, it may not get another. As Colin Gray and John Sheldon say in their work "Spacepower and the Revolution in Military Affairs,"

> (It) is not an avoidable issue. It is not an optional extra. If the US armed forces cannot secure and maintain space control, then they will be unable to exploit space reliably or reliably deny such exploitation to others. The US ability to prevail in conflict would be severely harmed as a consequence.[1]

Unique Historical Opportunity

This moment in history is uniquely suited for the US to develop its ability to fully exploit space for national security purposes. In the past, the superpowers have been locked in a tit-for-tat military buildup, with expenditures going toward next generation terrestrial weapons. This strategy was required to ensure neither power gained a long-term superior foothold on military technology. Such a situation was considered dangerous due to the perception of world domination each power had of the other's intentions.

With the demise of the Soviet Union, the world is much less threatening to the *national survival* of the United States. The present and near future offers the US the opportunity to spend its military fiscal resources on *not* the next generation military capability, but on following generations. In this way, the US can position itself to ensure its security for the long term by developing technologies based on a strategy to control and exploit the all-encompassing medium of space, vice spending dwindling funds on the *very next* generation terrestrial weapons which were developed and based on threats which no longer exist.

The bipolar state of affairs that dominated the globe since the end of World War II has been transformed to what is now, essentially, a unipolar world. However, unipolarity does not connote increased safety and security for the United States, as evidenced by multiple, direct US military involvement in crises throughout the world.

What unipolarity negates, though, is the requirement for the tit-for-tat military acquisition cycles that dominated the Cold War era. For the first time since our rapid buildup for World War II, and the continued military technological ones-upmanship that followed throughout the Cold War, we are in the enviable position of not having to *field* massive numbers of new technology weapons.

Ironically, we find ourselves in a *similar* position to that of post-Great War, Treaty of Versailles-limited, Germany. Throughout the period from 1919 to 1935, Germany pursued new technologies while not fielding new systems. By not paying for large inventories of new technological armaments, the Germans were able to take full advantage of skipping technological generations, and entered World War II with forces technologically superior to their adversaries.[2] In a similar manner, we should take advantage of our current unique historical position by not spending billions of dollars to *field* each new technological generation, but rather put these resources toward development of tomorrow's space capabilities -- in order to realize all of the military and political advantages previously analyzed.

That said, the world is now much more dangerous vis-à-vis smaller scale military operational requirements, especially in light of declining budgets and a national trend toward realizing the "peace dividend." The U.S. must use its resources wisely to maintain its technological edge. While focusing on tomorrow's military technological needs, it must retain the ability to train, equip and maintain its present forces, in order to realize their full potential in reacting to global crises. This is possible through careful defense budget allocations changes (discussed in detail in chapter 9). Fortunately, this unique historical period offers the opportunity to advance future technological capabilities, while maintaining military might amid limited resources. This plan assumes constant defense budget value in real terms.

Fortunately, much of our nation's future space capability is currently being, and will continue to be, funded by civil concerns to accommodate civilian economic requirements. However, certain technologies exist for military exploitation only. These technologies, and the basic science research needed to bring them to fruition, must be funded by the military budget.

This is where the money saved by not fielding the next generation terrestrial force structure could best be applied.

The military budget should be used for two basic purposes -- to *train, maintain and equip* our forces with sufficient, present-day technology weapons to meet today's omni-present military requirements, and to *conduct effective research and development* into future, militarily applicable, technologies. This latter capital commitment must be coordinated with commercially developed and available technologies to ensure maximum value and efficiency.

This proposal assumes, as a calculated risk, our current military technologies are capable of dominating any present, or immediately foreseeable, eventuality. A rapidly resurgent Russia, or similar threat (e.g. expansionistic China), could require an expandable US military industrial base. The U.S. can retain this expansion ability, realize technological advances, as well as save money, by continuing to develop future systems through their engineering and prototype (including production prototype) stages only. Unfortunately, an analysis of recently released DoD budget numbers indicate this is not being done (a detailed analysis of this is found in chapter 9).

The U.S. stands at a historical crossroads. Some high-profile national leaders have discussed this very issue. U.S. Senator Bob Smith talks of this opportunity when he says

> I see an opportunity for us to exploit this period of unchallenged conventional superiority on Earth to shift substantial resources to space. I believe we can and must do this. And if we do, we will buy generations of security that all the ships, tanks, and airplanes in the world will not provide. This would be a real "peace dividend"—it would actually help keep the peace.[3]

General Howell Estes (USAF, ret), former USCINCSPACE, agrees, "In the decades to come, spacepower -- *spacepower* -- will accomplish many of the same functions that airpower does today."[4] At the 1997 Air Force Association National Symposium, he went on to hint at this unique historical opportunity when he suggested the USAF heed poet Robert Frost's point in the poem "A Road Not Taken," "…and I took the one less traveled by, and that has made all the difference." He expanded on this point by agreeing with what the CSAF, General Michael Ryan, had discussed earlier in the Symposium about the need to balance limited resources -- but General Estes went on to make the point that, "…we've got to be sure we're paying attention to our future. We must overcome our fear of change and set a course to the future by 'taking the road less traveled.'"

Conclusion

The U.S. is in a unique historical period in which it can more easily take the path that ensures its interests are robustly defended and its technological superiority is maintained and expanded. In this way, the US can realize the advantages of spacepower as formerly illustrated in this thesis.

In this era of increased military requirements and declining resources, the U.S. must retain a complete and well-trained force, as well as maintain its technological edge for the future. Attaining this technological edge will require fundamental changes in the way the U.S., and the USAF in particular, does things -- culturally, organizationally, and fiscally. Part II continues with a discussion of such things -- and acknowledges the 500 year old words of Machiavelli

> One should bear in mind that there is nothing more difficult to execute, nor more dubious of success…than to introduce a new system of things: for he who introduces it has all those who profit from the old system as his enemies, and he has only lukewarm allies in all those who might profit from the new system.[5]

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[1] "Spacepower and the Revolution in Military Affairs." *Airpower Journal, Fall 1999.* Maxwell AFB, AL. p. 36.
[2] There are those who will criticize this argument based on the fact that even though Germany entered WORLD WAR II with superior technological capabilities it lost the war. Advanced technological capabilities can never make up for morally corrupt and militarily inept political leadership.
[3] "The Challenge of Spacepower" A speech given by Senator Bob Smith on 18 November 1998 to the Fletcher School and Institute on Foreign Policy Analysis at its annual conference in Cambridge Mass.
[4] Extracted from General Estes' speech to the Air Force Association National Symposium, Los Angeles, CA, 14 Nov 1997.

[5] Extracted from *The Prince*. Machiavelli.

Chapter Seven

Change of Thinking

One should bear in mind that there is nothing more difficult to execute, nor more dubious of success than to introduce a new system of things: for he who introduces it has all those who profit from the old system as his enemies, and he has only lukewarm allies in all those who might profit from the new system.
-- Machiavelli, "The Prince"

National safety would be endangered by an Air Force whose doctrine and techniques are tied solely to the equipment and processes of the moment. Present equipment is but a step in progress, and any Air Force which does not keep its doctrine ahead of its equipment, and its vision far into the future, can only delude the nation into a false sense of security.
-- General of the Air Force H.H. Arnold

Either you are a separatist or a conformist. The separatists will often be killed by the party faithful; the conformist will kill the very organization they seek to defend.
-- General Charles Horner, former CINCSPACE

Overview

The first -- and sometimes the most difficult -- step for any significant successful change to occur for any size organization is for a fundamental change in perspective. In this vein, it seems the opportunity to fully realize the potential of aerospace power can be increased, if the U.S., the Department of Defense (DoD)/joint (unified command), and the USAF all modify the way they think about the use of spacepower.

By and large, the U.S. population does not see space as a formidable environment for military operations. The U.S.' image of space as a peaceful place began with the public policies of the Eisenhower Administration. The limitations imposed by the 1967 Outer Space Treaty were a direct result of these early thought-processes regarding the use of space. Today's capabilities and geopolitical realities demand a reevaluation of these perspectives -- the opportunity exists to educate the public on the possibilities and limitations of military spacepower. The U.S. should embrace space as simply another warfighting medium and get on with the advancement of military spacepower for the good of this nation's sons and daughters.

From the DoD and unified perspective, it will remain advantageous that CINCs are the requirements drivers. An opportunity exists for these warfighters to be more educated as to the possibilities (and limitations) of advancing spacepower capabilities. This education, coupled with serious attempts at integration of space capabilities into wargaming and force experimentation, will portend advancing spacepower requirements -- from today's purely supportive requirements to requirements to apply direct fires.

From a service perspective, the USAF can increase its prominence as the nation's aerospace force by honing its perspectives on the exploitation of spacepower. The most rapid way for this to occur is simultaneously from the bottom up and the top down.

Changes discussed here span the seemingly mundane like changes in professional education to the relatively organization-jarring like institutional name changes and changes in leadership development. This paper is not designed to be all encompassing in nature. It is patently obvious many other changes are possible and advantageous. However, the changes discussed herein are basic in nature, yet involve core self-perceptions -- ultimately strengthening the USAF's long-term existence as the nation's, and the world's, premiere military aerospace institution.

<u>Changes to National Thinking:</u>

Ultimately, how the nation thinks about the military use of space will determine the realization or unrealization of spacepower's military potential. In the representative republic of the U.S. it is the voice of the people that carries the day when budget and policy decisions are made. Regardless of strategic, operational, or tactical considerations of any type of military force, fiscal reality determines the efficacy of any form of military power.

In this vein, the people can be educated in the potentialities of spacepower (both positive and negative) in order to make informed decisions about its development. History is replete with parallels for the standing up of nation's armies, navies and air forces.[1]

As mentioned earlier in this thesis, land power had the likes of Sun Tzu, Clausewitz, and Fuller to educate the masses as well as the military professionals. Sea power had the likes of Mahan to write and educate the public and naval professionals about the importance of protecting sea lines-of-communications, fleets-in-being, etc. Airpower was blessed with folks like Douhet, Mitchell, and de Seversky to carry the word to the people about the advantages of airpower. Spacepower has not yet had such success in educating the masses -- though writings on this subject are increasing.[2]

Instead, the U.S. population's opinions of space have been shaped by early notions of "space for peaceful purposes" and "space as a sanctuary" concepts, much of which grew out of the efforts of the Eisenhower Administration to limit military uses of space in order to protect its newfound capabilities to spy from space.[3] Hays terms this early period of space policy formulation as the period of "Squandered Inheritance."[4]

Today, there are those (even within the U.S. military) who still subscribe to such thoughts, somehow not realizing space has been militarized since the Eisenhower Administration, and not willing to accept man's nature to militarize every environment he can technologically overcome. Unfortunately, the potential to exploit today's technology and deal more effectively with geopolitical realities (as discussed in Part I) via the full exploitation of spacepower is hindered by this continued public perception of space as a peaceful place.

Space is not peaceful. It hasn't been peaceful since man first acquired the capability to access it (the ICBM grew out of this capability). As technology has advanced, so too has the military uses of space -- to the point that today the U.S. could field credible space force application and control capabilities given public (and therefore political leadership) go-ahead.

This lack of understanding on the public's part has adversely affected the nation's political ability to achieve a cohesive space policy. While some in Congress have cautioned the Air Force for seemingly disregarding advanced spacepower capabilities (i.e. force application and space control), there are other national leaders who believe space should not be militarized further. Unfortunately, a complete discussion of this policy dichotomy cannot be adequately completed in a work such as this. However, enough of the conflict is presented herein to frame the general problem. As a recent editorial on national space policy noted

> The United States lacks a single space policy…Much like Janus, the two-faced god of Roman mythology, US national security space policy continues in the 41-year old tradition of looking in two different -- and at times, opposite -- directions. Proponents of two competing viewpoints vie for primacy on the space policy stage. The first group is made up of people who support the written US policy and regard space as "a medium like the land, sea and air" where military activities shall be conducted to defend and fight for America's interests. In contrast, the other group regards space as a peaceful preserve, a sanctuary that man must never despoil with his bloody strife. This philosophy manifests itself in our public rhetoric, funding priorities and treaty commitments…The policy debate focuses on two fundamental mission areas: space control and force application…Interestingly, the new directive makes clear that it does not provide the definitive guidance regarding such controversial missions…Renowned Cold War strategic thinker Raymond Aron somberly observed in 1966 that 'short of a revolution in the heart of man and the nature of states, by what miracle could space be preserved from military use?[5]

Fortunately, the U.S. has not had to face up to a determined national space policy because it has enjoyed a lengthy period of relative national security. However, for the reasons discussed in Part I, as well as the historical facts that wars will happen and man will militarily exploit any medium he can technologically conquer, the U.S. should not remain of two minds on the subject of military space capabilities. To facilitate this, the U.S. population can be educated on the reality of space combat -- eventually making it as second nature as air, land and sea warfare thought is today. This national intuitiveness may then be reflected in sound political decision making.

As of this writing, the United States Congress' Commission on National Security in the 21st Century has published a working paper in which it claimed "the United States must remain preeminent in space if it is to advance its national interests early in the next (this) century."[6] The group is led by former senators Gary Hart and Warren Rudman, and published its first report in 1999 detailing its projections for the nation's security environment early in the 21st century (formerly noted in this paper).

Its next report focuses on US space capabilities. It claims "The importance of space cannot be overstated. In the future, satellites could provide warfighters with a wide range of situational data and *decisive weapons capability* (emphasis by author) -- critical strategy, policy and resourcing decisions need to be made."

The working paper outlines three alternative strategies for meeting US security objectives in this century. The strategies range the gambit from doing almost nothing in space to fully operationalizing the medium.

The first alternative is dubbed "minimal militarization." It involves mostly diplomatic activities to "ensure" as few anti-space and cyber-interference systems as possible are developed and employed. "This approach places great emphasis on treaties, bilateral agreements and establishing international norms by example and through diplomacy. Success is dependent on the ability to verify compliance, enforce compliance and deter noncompliance once conflict between parties occurs. Failure may severely affect national survival."

The second alternative is "hedging." It involves developing and integrating unique space capabilities to attain national objectives. "Weapon systems would be developed and pursued short of deployment in near-term anticipation of, or response to, threats and capability requirements. In conjunction with space force development, the US would undertake a coordinated effort to get buy-in from allies and partners. This approach is a transition strategy." This approach depends on a reliable US ability to know what foreign space developments are occurring in order to have sufficient warning of any potential threat.

The last strategy is called "strategic shift." It emphasizes moving toward a significant space force structure, and away from a large terrestrial one. This approach would be a means of "exploiting US technical and operational strategic advantages and trends and move from a regional security focus to a global security focus that is enabled through the use of outer space." This approach hinges on a significant increase in research and development efforts -- and would probably be strongly opposed by most nations.

Fortunately, a national effort is underway to wrestle with the issues sited in this paper. Hopefully, this Commission's report will have great impact on near-term national decisions. For reasons previously stated, a move toward options two or three seems best.

<u>Changes to DoD/Joint Thinking:</u>

As national perspectives on spacepower change, so too would the military's. Whether this happens simultaneously or not is a classic "chicken or egg" debate. National perspectives naturally drive DoD perspectives, but so too do DoD perspectives drive national. It is probably most accurate to bet both will influence each other in various ways. Regardless, change in both would be a positive thing.

The good news is the US' military organization and span of control is already advantageously setup to host this change. The basic tenant of US military span of control is the Commander-in-Chief (CINC) is the warfighter. The services are not. They are merely the organizations to organize, train and equip forces for the various CINCs to employ. It is the ultimate responsibility of these CINCs to most effectively and efficiently round up, plan for, and engage these forces. As General Ashy wrote in his *Aviation Week and Space Technology* article "Military Space Operations and Organizations -- Some Thoughts About the Future," "The days of service-only operations in a theater are over. Conversely, service provisioning of interoperable, capable forces to a joint/combined operation has been enhanced."

Because of this, the CINCs drive warfighting requirements via the Joint Requirements Oversight Council (JROC) process. This process makes or breaks the possibilities of various warfighting technologies seeing the light of day. If a capability is deemed operationally viable and additive to a CINCs warfighting toolkit it becomes a requirement. If it becomes a requirement, it becomes funded. If it gets funded, it probably gets fielded.

Admiral Harold W. Gehman, Jr., Joint Forces Command CINC, recently spoke of this reality and its relationship to advancing military capabilities:

> "A small but vocal group in Congress is concerned that the US military is too wedded to its careers, organizations, and platforms to do anything more than make partial product improvements from one generation to the next. These members of Congress and others are pressing the Department of Defense and the uniformed military to think bigger and longer range."[7]

In light of this, the challenge for expanding spacepower capabilities is the education of CINCs and their staffs about capabilities and limitations. Ask a CINC staffer from any service the reason for various terrestrial force technologies and any officer could discuss nearly any such technology with a certain amount of credibility and insight, e.g. an Army infantry officer could probably discuss strategic airpower relatively coherently (even if he doesn't necessarily agree with it). Ask the same staffer about space force enhancement technology, and they could probably discuss it with a little less detail and insight. However, ask the same staffer about space force application or control technology, and most would probably return a blank stare wondering why the interest.[8]

Attendant to this education process is the requirement for advancing spacepower technologies to be integrated and employed in the various CINCs wargaming and experimentation processes. It is in the crucible of such tasking that education could occur, capabilities and limitations could be vetted and understood, and spacepower technology could become viewed as simply another tool in the CINCs' warfighting kits.

To date, most such exercising and experimentation have been accomplished by various service wargames and experiments. Most notably, the USAF and the Army have integrated today's, as well as tomorrow's, spacepower technologies into future look wargames, as well as force experimentation.[9] It is notable that such service efforts have determined advanced spacepower capabilities are extremely useful as simply another arrow in the military quiver (vice utilized as a "silver bullet" vis-à-vis nuclear weapons of the past and present). Tied to this utility, however, is the notion such capabilities will be limited due to cost.[10] Additionally, these games and experiments have illustrated the need for increased emphasis on space control capabilities.

Though advanced spacepower capabilities are deemed useful; they are also limited and, therefore, deemed vulnerable to attack. Given today's dire replenishment capability associated with an aging and inadequate launch infrastructure, this limitation becomes critical.

The bottom line is the US military structure is setup well to usher in advanced spacepower capabilities -- between CINC's staffs and the services, these resources can be integrated into the general warfighting toolkits of the CINCs. That said, an education process seems beneficial. In his *Aviation Week and Space Technology* article "Military Space Operations and Organization -- Some Thoughts About the Future," General Ashy makes the points

> Goldwater-Nichols resulted in much needed improvements in the way service-provided forces operate effectively together in joint and combined arenas…military requirements are identified by the unified commanders and then reviewed by the Joint Chiefs before service acquisition programs can commence…I submit that as we evolve and expand our space forces, we should continue to endorse these processes and relationships which will serve well; and also recognize that a unified command is currently established to conduct assigned space enhancement and force support missions today. The "air model" suggests these [missions] will soon include control and [force] application capabilities.

<u>Changes to USAF Thinking:</u>

Top down changes in institutional thinking began to accelerate in the USAF during the tenure of Air Force Chief of Staff General Ronald Fogelman. It was under his watch the philosophy of the USAF became "we are moving from an air and space force to a space and air force on our way to a space force." This fundamental shift in institutional logic accelerated what was viewed by some as previously stagnant USAF space doctrine and thinking.

Since General Fogelman's retirement, some believe this effort has slowed. The term "air and space force" has been replaced officially with "aerospace force," which critics claim hint that, as an institution, the USAF is stepping away from a movement toward more spacepower in the interest of merely "integrating" air and space powers. The USAF refutes this notion, pointing out the best way to achieve advanced space capabilities is via a logical evolution of aerospace power.

Senator Smith discussed this issue in his address to the Fletcher School on 18 November 1998

> Expanding and refining our ability to gather and transmit information has been the Defense Department's principal focus in the space arena. The USAF's space budget is dedicated almost entirely to the maintenance and improvement of information systems as

> a means of increasing the effectiveness of existing forces here on Earth. But as important as early warning, intelligence, navigation, weather, and communications systems may be, today they are basically dedicated to supporting non-space forms of power projection. Even the USAF's Space Warfare Center and Space Battlelab are focused primarily on figuring out how to use space systems to put information into the cockpit in order to more accurately drop *bombs* from *aircraft* (emphasis in original).
>
> This is not space warfare -- it is using space to support air warfare. It is essentially the space component of "information superiority….If we limit our approach to space to just information superiority, we will not have fully utilized spacepower.

All of that said, there is growing evidence the USAF is internalizing this required shift. In 1998, the USAF Directorate of Plans (AF/XP) stood up an office dedicated to advancing an "Aerospace Integration Plan." This office is known as the Aerospace Integration Task Force (AITF). Led by one of the relatively few USAF officers with both air and space operational expertise, the personnel in the AITF have formulated a plan of action to better integrate air and space operations. Most of the "top" actions lend themselves to more fully realizing the potential for spacepower. Some of the proposed actions deal with more short-term requirements for better integrating space into air operations.

How can the USAF fundamentally shift its perspective to view spacepower as a fully capable subset of aerospace power? Three basic perspective shifts seem most appropriate. First, the USAF could call itself what it is and wants to be. Second, the USAF can grow leaders who are operationally expert in both of its core missions -- the application of air and space powers. Third, the USAF can educate itself to bring its institutional operational space thought process to the same level its operational air thought process is today -- to include all phases of professional military education, as well as dynamic wargaming and force experimentation.

Call Itself What It Says It Is

An institutional name change is a simple, yet very emotional, identity-ridden, and complex thing. Yet, by simple virtue of this complexity, an institution that voluntarily undergoes such a reidentification inherently identifies itself as seriously fostering change.

As previously noted, the USAF has been talking of itself for years (at least since General White in 1957) as an aerospace force. That said, though there have been plenty of high-level discussions, it has never found itself willing to fundamentally identify itself with this concept by calling itself what it says it is -- the United States Aerospace Force.

Some critics maintain the simple fact this fundamental change has not occurred lends credence to their arguments the USAF is unwilling to see itself as a "full up" air <u>and</u> space power. By maintaining its nomer of Air Force, while stating it is 'really' the nations air and space force, the critics are given ammunition to argue the institution of the USAF is unwilling or unready to forego parts of its air mission for space alternatives (except space's "unsexy" support missions).

This is ironic given the USAF's past. Even in its most arduous days of conflict with its US Army parent, the Army's air component was allowed the nomer Army Air Corps. Such a nod to advancing operational reality seems appropriate for the space component of the USAF. And as the USAF has declined the notion of a separate but related Space Corps, it can demonstrate its determination to advanced aerospace power by stepping up to the formality of calling itself what it truly is -- the United States Aerospace Force.

The institutional mindset this would inculcate would advantageously manifest itself in many ways. "Airmen" would begin to think of themselves as "aerospacemen," truly beginning to think integrated effects of both basic missions of aerospace power. Spacepower would begin to be thought of by aerospacemen in terms of totality of effects, vice the support-only space capabilities presently thought of.

Part and parcel to renaming the US Air Force the US Aerospace Force (notably, both the "USAF"), could be the renaming of Air Force Space Command to Space Combat Command, as an operational organizational equal of Air Combat Command. This change would put spacepower on an equal footing with airpower within the US Aerospace Force (organizationally, and within aerospacemen's minds). It could also go a long way toward advancing spacepower interests nationally.

Coincidentally, the new United States Aerospace Force would begin to grow air and space smart leaders from the ground up. A newly commissioned second lieutenant, or newly minted enlisted aerospaceman (formerly enlisted airman), would identify themselves right away with their service's basic characteristic -- the application of the US' air and space powers (aerospace power).

This basic change could also lend itself to buttressing the education of these new arrivals, as well as their more experienced compatriots already in ranks, as they attend professional military schools throughout their careers. Discussion of the space component of aerospace power would be more readily accepted as part and parcel to the institution's identity, vice often brushed off as merely a supporting criteria to be only fully understood by those tasked with its employment (those "space geeks").

Growing Leaders Within the United States Aerospace Force

The USAF has always put flyers in command of its Space Command -- it has been suggested by some that this is due to its air-superior mindset. Given notable exceptions to commanders of 14th Air Force (the USAF's space warfighting component), and some space wings, senior space leaders have, by and large, been flyers.

Conversely, there have never been space operators commanding flying operations. Is this wrong? Not necessarily. Certain "stovepipes" seem best maintained for operational, as well as safety's sake. However, the same reasoning could be applied to operational space leadership, as well. The best leaders are those who internalize and fully understand the operation they are commanding.

So, for the moment, it seems easiest to maintain two stovepipes, i.e. flyers commanding flying units, space operators commanding space units. However, given today's expansion of USAF space training, possibilities exist to begin melding these stovepipes together. Care should be taken to ensure the leaders within each component (air and space) have at least some amount of experience in their opposite operational expertise. *That is, today's air leaders should be space smart air experts. Today's space leaders should be air smart space experts*. This will be a requirement for at least a generation until the effects on the personnel system outlined below "rise to the top" creating Aerospace Force "renaissance" leaders.

What could be the USAF "renaissance man" approach to growing operational leaders (see figure one, next page)? Flights, Squadrons, Wings, and Numbered Aerospace Forces in the future need to be commanded, and manned, by operators experienced in all facets of employing aerospace power. These officers will need to have experience in both air and space operations. Given the technical requirements of operations in both components of aerospace power, getting this experience is problematic -- but possible. To do this, the Aerospace Force could facilitate another fundamental change in its former corporate mentality -- broad operational expertise earlier in a career.

Given a strong and broad underlying knowledge of aerospace power received from a commissioning source with revised syllabi, as well as a revised Air and Space Basic Course, the "renaissance" second lieutenant would enter operational training with a broader perspective. Through mid-captain this air or space operator needs to enhance basic skills, becoming flight lead, instructor, evaluator, flight commander, etc in his/her operational specialty. Along the way, the young officer will get increased exposure to the "other" aerospace component while operating his/her specific system, as well as attending a syllabi-enhanced Squadron Officer School and other professional education opportunities (Weapons School, etc). At this point, the officer will begin expanding his/her professional operations horizon in "cross-flow" operational assignments.

Enroute to their first operational cross-flow assignments, space operators would attend a flying initial qualification course designed to prepare them for operating in a flying unit (AOC, OSS, etc). Likewise, flyers would attend a space initial qualification course to prepare them for their first professional exposure to space operations.

With the advent of organizations tasked with dual-use applications, such as Operations Centers and Squadrons and other units growing from the Aerospace Expeditionary Force concept, the officer will be given the opportunity to become adept at learning employment of aerospace power writ large. For example, the aviator will understand the nuances of LEO as applied to force enhancement, space control or force application assets, and the space operator will internalize the requirement for accurate RTIC in a high-threat SEAD environment. Both will understand the BMC3ISR associated with aerospace force. Both will deploy with their units when required, learning the "field" requirements of their respective units. Invariably, both will come away from this mid-captain assignment better prepared to lead in the Aerospace Force. Not all officers will continue these "crossflow" opportunities beyond this first exposure.

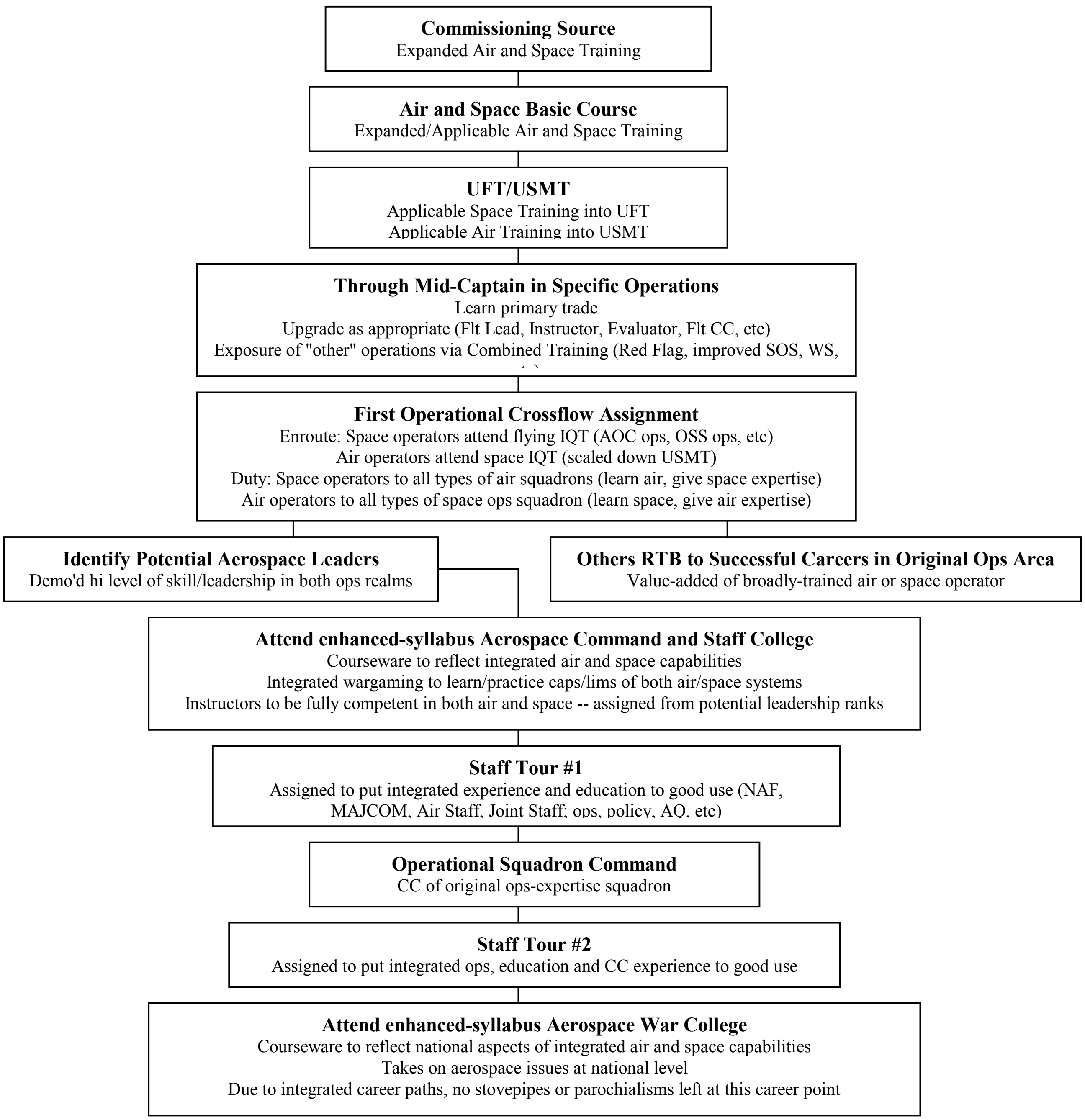
It is at this point in a career when aerospace leaders would start to select those young officers with potential for leading an aerospace force. The remainder will return to their initial operational duties and continue successful careers. Those "selected" will continue to learn more about the application and leadership of the nation's Aerospace Force.

It is at this point the basis for fully integrated leadership would be realized. The Aerospace Force will have produced operationally significant quantities of "air smart space experts" as well as "space smart air experts."[11] This reality would bode well for producing completely integrated future high level Aerospace Force leadership.

Leaving the first broadening assignment, the officer would be a major and attend an enhanced syllabus Aerospace Command and Staff College. No longer would space lessons be conducted blandly, separately and in a matter of a few hours while the class sleeps in the auditorium. Courseware would be developed integrating air and space power capabilities and limitations. The academics would require capabilities and limitations of each component be analyzed and employed in such a manner to complement each. Integrated wargaming would become a major teaching and learning tool (wargaming software will handle all aspects of aerospace warfare; there will be no "trust me" cards). Instructors would be fully competent in all matters aerospace -- and would be assigned from the ranks of those selected to continue in aerospace leadership. If the officer is selected for the School of Advanced Aerospace Studies, their curriculum would truly be that of integrating and employing "aerospace" assets in a joint or combined environment, not merely the history of air with a wink at space in a technology class along the way.[12]

From school, these officers would be assigned staff tours where their integrated operational experience can be put to optimal use. The Joint Staff, Aerospace Staff, NAFs, MAJCOMs would all be fertile fields for their expertise and further their learning the realities of air and space operations.

Those officers coming off their staff assignments who are ready to command operational squadrons would do so. Unless a very large leap of faith occurs, officers whose initial operational backgrounds were flying would command flying squadrons, while those who came from space would command space squadrons.[13]/[14]



Operational Group/Wing Command
Due to experience, can command any type of ops group/wing
Experience allows understanding of applicable technologies and ops
Spearhead integration/synthesizing of all aerospace capabilities

General Officer
Career-long integrated experience allows TRULY GENERAL general officers
Parochialisms fully shed by this point
Aerospace Force GOs will expertly exploit all aerospace capabilities as Joint Forces
Aerospace Force Commanders and make informed decisions about future force structure

Figure One: Integrated Aerospaceman Career Path

After this more senior operational tour, and having passed the "command test," these officers would continue as aerospace warriors and leaders. They would go to another staff assignment, furthering their integration experience, but at a more responsible level. At this point, for example, they could be in charge of programs bringing more advanced aerospace capabilities into the service -- and, because of their backgrounds, would better understand why and how to do it best.

The graduated squadron commander would then move on to another enhanced syllabus PME -- Aerospace War College. Here the officers would take on aerospace issues at the national level. It is imagined all operational "stovepipe" parochialisms would be shed by this point, enhancing the educational experience for all professional aerospace leaders in attendance.

Upon graduation, and given the appropriate rank, these officers would become operations group commanders -- in any type of operation. Their experience and knowledge would be such that each could command any group. Each would understand the operational characteristics of their group's technology and capability -- and more importantly, understand how these enhance the warfighting capability of the Aerospace Force as a whole. As operations group commanders, these aerospace leaders would be the spearheads for integrating and synthesizing all aerospace capabilities in any fight. The same reasoning applies to these leaders moving on to command operational wings.

As aerospacemen since their initial training, and having proved their abilities to lead all facets of the aerospace team, these officers would be well placed to lead the Aerospace Force in the General Officer ranks. The very meaning of "general" would be realized within the top ranks of the Aerospace Force. Parochialisms would be fully shed by this point. Service priorities would reflect this shift, and Aerospace Force general officers would expertly exploit all aerospace force capabilities as the Joint Forces Aerospace Force Component Commander for any CINC.

If all of this falls into the "too hard to do" column, option two would be for air and space leaders to be grown separately -- and their expertise melded at the senior officer level. Some air and space operators today suggest this is the saner path -- and it may very well be. They point out that due to the technological complexity involved with both components of aerospace power, it takes air or space career professionals to command in their respective technical specialties. There is a certain logic to this argument -- though certain aspects of integrated knowledge would be lost.

Educating the Aerospace Professional

Another fundamental shift in the USAF to further air and space expertise within the ranks of the Aerospace Force could be a change in the institution's operational education concepts. This change would pervade the entire spectrum of education from pre-service entry, to the Air and Space Basic Course, to operational training, and all PMEs.

Certain aspects of educational change have just been covered in the subsection above. Two important aspects were not.

With the broad understanding commensurate with their pre-commissioning and Air and Space Basic Course as part of their basic knowledge, student Aerospace Force operators could be trained on the integrative points of their opposite aerospace mission while undergoing Undergraduate Training.

Undergraduate Flying Training (Undergraduate Pilot Training/Undergraduate Navigator Training) students could receive space operations training while undergoing their flying training. Obviously, such training would be designed to integrate, not detract, from flying training. In the force enhancement space mission, there are plenty of courses possible, and important, to teach fledgling aviators. Space-based navigation, communication, weather, targeting, surveillance, and reconnaissance all beg to be taught in such an environment.

More advanced space capabilities like force application and space control seem readily integrative into their specific weapon systems' Initial Qualification Training as these new aviators learn to employ their machines in the total fight -- for example, during latter Surface Attack Tactics phases for fighter and bomber aircraft. Such space capabilities would force changes in air tasking order (hopefully soon to be Integrated Tasking Order, reflecting air and space asset tasking) requirements, as well as some tactics employed by air assets.

As well, fledgling space operators attending Undergraduate Space and Missile Training (USMT) would benefit from some basic flying training. How what they do affects the flyer and his/her equipment seems especially worthy of study, as well as techniques to enhance capabilities of air platforms. Space control and force application training Initial Qualification Training could include these operations' possible impacts to air tasking realities, as well as tradeoffs and planning considerations when employing such weapons in a space-air (or space-air-land-sea) combat environment.

Some of these additions and changes could be instituted now. Obviously, others will be appropriate in the future -- but could be planned for now (e.g. space force application). Bottom line is that integrated operations training within basic and initial qualification operational training could go a long way toward furthering space and air integration in the Aerospace Force.

Conclusion:

The first step to this nation realizing complete spacepower capabilities seems to be a fundamental change in perspective from the national level to the DoD/unified and to the institutional USAF level. Some of this perspective or cultural change would be easy; some would affect traditional cores.

At the national level, the populace can be educated to embrace spacepower as it has all other advancing military powers. The education of the early twentieth century US public vis-à-vis airpower seems an appropriate analogy. Spacepower needs a deSeversky -- as well as a Douhet and Mitchell -- to take the word to the population. Talking and educating within the institutional military is also important, but in the representative republic of the US, it is the people, and their elected representatives who will enable requisite funding and policy shifts. Additionally, it is the people's elected leaders who would formulate a cohesive national spacepower policy.

That said, it seems the DoD can also benefit from increased spacepower education. Fortunately, the system in place today will result in requirements for the advancing spacepower capabilities as they come along. The CINCs, with the tutelage of the Aerospace Force, could better realize the advantages of fully functional spacepower and require these capabilities in their arsenals.

The USAF has many things it could do to advance itself into the twenty-first century, and beyond, as the US' aerospace force. First, it can call itself what it says it is -- the United States Aerospace Force, manned by aerospacemen, with its two largest component commands being Air Combat Command and Space Combat Command. Secondly, it can change the way it grows its operators as well as its leaders. These changes would result in general officers who are truly "general" in the employment of all facets of aerospace force. Lastly, the USAF can change the way it educates its personnel -- from pre-training through operational training, and professional military education, to assignments.

These are by no means the only things the USAF can do to ensure its future. The Aerospace Integration Task Force is hard at work on a document that will go a long way in better integrating air and space operations today, and some ideas that will better herald advancing spacepower capabilities.

With these perspective changes laid out, this paper now turns to suggestions for organizational changes to more effectively integrate space into the Aerospace Force. Some of these may also seem troublesome to institutional mindsets, but may help advance the nation's aerospace power capability into the 21st Century.

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[1] In their *Air Power Journal* essay, "Spacepower and the Revolution in Military Affairs," Gray and Sheldon make some studious observations about developments of spacepower to nations' naval and air powers. Though they don't draw distinctions between various powers' development and the nations' populations, their use of the "strategic logic" of it all is persuasive.

[2] As USCINCSPACE, General Estes instituted a project to lay down initial spacepower theory. The result of this work is the book <u>Space Power Theory</u>, by Jim Oberg -- a great start toward comprehensive spacepower theory.

[3] See Peter L. Hays, "Struggling Towards Space Doctrine: US Military Space Plans, Programs, and Perspectives During the Cold War." Fletcher School of Law and Diplomacy, May 1994. In this work, Hays deeply analyzes the public perceptions generated by the Eisenhower Administration's maneuverings to protect its ability to use space as an intelligence source. He notes the administration's first-ever US space policy was based on three main objectives:

1. To investigate and exploit the potential use of space to open up the closed Soviet state via satellite intelligence.
2. Design policies to create and protect a new international legal regime which would legitimize satellite overflight for all "peaceful purposes" including reconnaissance.
3. Investigate space for scientific purposes.

Ironically, these policies led to the development of what many today consider the first space force application technology -- the ICBM (as a launch platform for these "peaceful" satellites).

[4] Ibid, p. 62.

[5] "Two Faces of US Defense Space Policy." *Space News*, 6 Sep 1999.

[6] The data discussed herein comes from an article in *Inside the Pentagon*, 13 Jan 00.

[7] "Joint Vision 2010 Needs Stronger CINC Voice, Gehman Says." *American Forces Press Service*, 17 March 2000.

[8] General Ashy discusses this in the aforementioned article. After a short dissertation on what space is ("the fourth operational medium"), he says, "Importantly, we must understand this before exploring integration and organizational options and command relations."

[9] For in-depth looks at some examples of this see Army After Next, USAF's Global Engagement series, Aerospace Future Capabilities Game 1998, and Joint Force Experiments 1998 and 1999 after-action reports.

[10] Most games have demonstrated the capabilities are fully tasked to the point of depletion; the irony being their own success, accompanied by their limited number, drives their depletion.

[11] As of this writing, the USAF is producing twelve "air smart space experts" at the USAF Weapons School's Space Division. Unfortunately, due to syllabus limitations no "space smart air experts" are being produced, i.e. flyers the WS do not take as many hours of space training as space operators take of air training. At present, only 2 hours have been allotted to the Space Division to teach flyers, though more is constantly requested. Intelligence students receive almost 8 hours of related space training, while Command, Control, and Operations students receive almost 30 hours of related space training. Conversely, space students receive 75 hours of "pure" air training, two weeks (113 hours) of "integrated" air and space training at Hurlburt's Operations Center Training Course, as well as fly four syllabus missions (air-to-air, air-to-ground, CSAR, and C2). Though not enough hours are available for air students to receive a more complete space education, the 2 hours they do get, coupled with interacting with their space student brethren during daily operations, as well as the Mission Employment phase, contributes to graduating "space familiar air experts" -- a big improvement from the past.

[12] As was the case when the author went through SAAS in 1994-1995.

[13] When discussing "space" units, the author means space and missile units.

[14] All else being equal, it would be far better if the leap of faith (and experience) occurred to the point any operational officer could command any operational squadron -- as they have the knowledge gleaned from at least two varied operational tours to use. That said, the author acknowledges the operational realities of daily command of a flying squadron.

Chapter Eight

Organizing to Exploit Space

I've always regarded space as the legitimate domain of the Air Force.
-- General Tony McPeak, former CSAF

I am less concerned with who does [the military space mission] than getting it done.
-- US Senator Bob Smith

The development of airpower has forced a complete reorganization of all the arrangements for national defense.
-- Billy Mitchell

Overview:

Part and parcel to shifting perspectives, changes in organization could also help usher in advancing spacepower capabilities. As with Chapter 7, these organizational change suggestions will be analyzed at three levels -- national, DoD/unified, and USAF.

From a national perspective, the multitude of space "rice bowl" organizations could undergo radical changes to coalesce military space missions into one military space entity. At the DoD or joint levels, changes can be made to command and control structures to more effectively employ advancing space capabilities.

Finally, within the USAF, there are multiple opportunities to inspire advancing spacepower capabilities via organizational changes. In general, these changes involve divestiture of tertiary missions within space organizations, broader USAF control of all military space organize, train and equip activities, and combining/synthesizing standing organizations to better realize present integration opportunities, as well as future advanced space capabilities.

National Organization Change Opportunities:

It has long been argued, and rightfully so, that national space priorities are extremely varied, and at times contradictory, due to the multitude of space-related organizations in existence. Many times, these organizations vie for funding and status at the expense of the nation's space capabilities in general. Span of control seems unwieldy at best and non-existent at worst.

A table appearing in a recent RAND study illustrates the complexity -- and attendant problems -- associated with the US' space organizations:

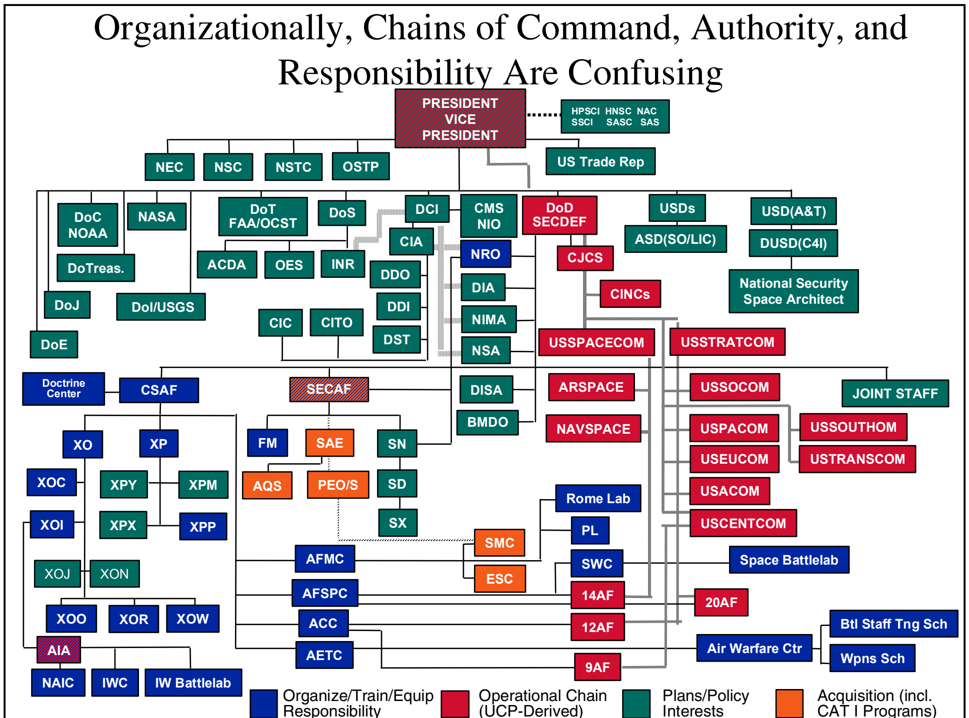

Figure One: Space Organization Complexity[1]

The RAND study says it best. "Viewed from an organizational process perspective, the existing chains of command, authority, and responsibility are confusing. This is largely because the number of 'players' in space activities today, from the national security sector (including military and intelligence activities) to the civil sector." RAND actually claims the chart understates the situation's complexity, in that it fails to show two other sectors (commercial and international).

As noted on the chart, several chains of command exist. These vary from operational (CINC/warfighting) to organize/train/equip (service and component) to policy (national) and acquisition.

> The "organize, train and equip" chain is shown in vertical lines. It flows through the Secretary of the Air Force (SecAF) and Air Force Chief of Staff (CSAF) chains. The SecAF also has responsibility for the acquisition of forces; the acquisition chain is shown in dark gray. Air Intelligence Agency (AIA) has both a warfighting responsibility with respect to information warfare and an "organize, train, and equip" responsibility -- it is shown cross-hatched.
>
> A number of entities, both within the USAF and outside in the DoD and other Cabinet-level agencies, have policy interests in whatever the Air Force does with respect to space systems and operations. Those entities are shown in light gray. The point is that the USAF cannot ignore the effect these other agencies and their actions have from a policy sense on the decisions the USAF may make with respect to integration, such as budget and manpower reallocations and organizational change. Finally, at the top, the President has multiple responsibilities as the NCA and the one who sets overall policy tone for DoD.

Most importantly, this discussion demonstrates the national quagmire hindering the USAF from fully advancing military spacepower capabilities. Though difficult, this problem can be fixed -- and the national policy makers who are calling for separating space from the USAF mission could correct this national roadblock to give the USAF the leverage required to advance spacepower.

The lines of control can be minimized and streamlined. It seems some type of national coordination is required to most effectively plan and manage advancing spacepower capabilities throughout the nation's civil, commercial and military components. It seems logical the White House' Office of Science and Technology Policy (OSTP) could be the best choice to take on this role in the near term, though some type of national space "czar" may be appropriate for the longer term.

DoD/Joint Organization Change Opportunities:

Spacepower's military component's organization could also be streamlined. The chart above illustrates the complexity and span of control problems inherent in managing military spacepower organizing, training, and equipping, as well as planning and execution roles. These complexities and coordination nightmares drive inefficiencies -- and when talking about the high costs of spacepower, these inefficiencies become gross.

That said, most of the streamlining and redistribution of authority will be discussed in the following (USAF-related) subsection of this paper. At the DoD and joint levels, it seems appropriate for the DoD, JCS and CINC's staffs to reflect the same amount of space expertise as they already do with air, land and sea expertise.

The Goldwater-Nichols Act wisely required a buttressing of 'joint' expertise. Due to this requirement, and the concomitant requirements for senior service leaders to have joint experience, the services now man these joint positions with their "best." Promotion rates and rates of command selection bare this out. The result has been an increased, though not perfect, capability to jointly execute the nation's military operations.

The good news is the data reflects that DoD and the JCS are beginning to man themselves to more effectively integrate space operations. Their percentages of space expertise have steadily risen. The problem today seems to be at the joint warfighting level -- in the CINCdoms.

Until very recently, few space experts have made the leap into the geographic CINCdoms. Up until two years ago, the only space expertise on CINC's staffs were transient "space teams" which visited during exercises -- if they could make it -- or during wartime -- with their little, or never, before explained/trained with/executed "little black boxes."

Obviously, CINCs were historically reluctant to "play" these space capabilities. The crunch of beginning combat operations was not the time to plan for and employ space capabilities previously not trained with or planned for.

Fortunately, General Joe Ashy, as USCINCSPACE and Commander, Air Force Space Command, along with General Michael Loh, as Commander, Air Combat Command, instituted the USAF Weapons School's Space Division. Like its sister divisions, this division was tasked with taking instructor-qualified space operators and, through a very rigorous training and evaluation process, turning them into weapons officers.

Since its inception 50 years ago, the USAF Weapons School has been producing weapons officers in most of the various USAF weapon systems. They become the experts in employing their particular systems in combat. These officers also historically have become commander's right hand men and women in times of conflict, advising on tactics and techniques.

It has been these space operators, graduated weapons officers, who have gone out to populate CINCs staffs -- taking their space integration expertise with them. Their success has been great, witness the three-fold expansion of graduate requirements in the field since the Space Division's birth a few short years ago.

Along with their weapons officer brethren, other space operators have been sent by Air Force Space Command out into the CINCdoms to take space to the warfighter. Importantly, like their weapons officer compatriots, these assignments have been in PCS, vice TDY, mode -- a vital requisite to providing "365/24/7" space expertise to the warfighter.

That said, such space expertise has not yet filtered up to the highest levels of CINCdoms. Generally, theater space coordination requirements fall on the Joint Force Air Component Commanders (JFACC) who do not fully understand spacepower's capabilities, or how to best integrate them. Unfortunately, this problem has often been compounded by conflicting service requirements for space support, as well the intelligence communities' penchance for historically looking upon space as their private province for deriving products.

For these reasons, as well as as the capability of spacepower continues to grow, the requirement for a highly placed space expert on the CINCs' staffs seems ever more important. As General Horner, former USCINCSPACE, has written, "As a result, we are entering an age when it is appropriate, if uncomfortable, to evaluate the need for a separate Space Component Commander."[2]

> Understandably the Air Force sees this a role of the JFACC, but I can assure you from my experience this is probably not the best way to organize and function. The JFACC/CFACC has his hands full with air operations as air has come to be the dominant elements in the battlespace in most situations. While he may be quite knowledgeable about space, if he is to be true to his air responsibilities, his space role will have to be an additional duty at a time when space may be of more importance than land or sea operations in the theater of conflict. The USAF as the most knowledgeable service about space must take the lead to examine the need for a separate role for a Joint/Combined Space Component Commander. This requirement arises from the increased role in space, the existence of a unified Space Command, and the growing role of information operations in warfare. It matters not the color of the uniform the JFSCC wears as long as he/she has access to the JFC and other Component Commanders to advise on how to best exploit space assets and to marshal them for directed operations…. *[This decision] is a recognition that space operations are quite different from air operations and have reached the importance and magnitude to warrant unique representation in campaign planning and execution*.[3] (emphasis added by author)

This requirement may be especially important in the near term as there are very few aerospacemen -- an idea discussed in the last chapter. This requirement would eventually be negated if the USAF were to begin growing aerospace leaders capable of commanding assets to gain required "effects" throughout the vertical dimension.

Just as important as properly organizing to best exploit space within the geographic CINCdoms is the proper organizational responsibility given to the nation's space Commander-in-Chief (CINC) -- USCINCSPACE. Though rhetorically the military's "one stop" space shop, United States Space Command (USSPACECOM) is only one of thirteen national or DoD agencies concerned with the nation's military space capabilities -- all having a vote on the military's use of spacepower.[4] In fact, this CINC does not have definitive control over "his" space assets. General Horner alluded to this when in congressional testimony he stated, "[I] exercise little control over [my] command." It has been suggested that, in reality, the COCOM granted to USCINCSPACE via the Unified Command Plan is shared with all thirteen of these agencies -- and the precedent for veto or delay is real.

The result seems to be a DoD space capability that is fractionalized and too complex for efficient and effective execution. To increase unity of command and the efficient and effective application of the nation's military spacepower, USCINCSPACE could have more than paper-authority to command and control US DoD space assets. United States Space Command could, in fact, become the nation's unified go-to command for all things space -- with the requisite authority to get the job done.

To realize this, every DoD agency with any space responsibility could be delegated in some way as subordinate to USSPACECOM. Lines of authority and coordination should be established and codified. Budget authority could be appropriately modified, as well (next chapter's discussion).

If the institutional momentum is too great for these agencies not to put their planning and execution responsibilities and authorities into USSPACECOM, these agencies' space responsibilities, authorities, and capabilities could be realigned to fall directly under USCINCSPACE. This would be a huge step toward the US military efficiently realizing advanced spacepower capabilities. Suggestions for the agencies' organize, train and equip responsibilities and authorities are discussed in the following USAF subsection.

Lastly, not only can USSPACECOM be assigned all national agencies' military space planning and execution responsibilities and authorities, it could also be assigned the planning and execution functions associated with all military spacepower missions -- space control, space force application, space force support, and space force enhancement.

It seems USCINCSPACE should be the CINC fully responsible for conducting space control, space force application, space force support, and space force enhancement operations. Relationships with the other unified commands can be codified to best meet all CINC's requirements.

<u>USAF Organization Change Opportunities:</u>

The opportunities for the US Aerospace Force regarding organizational changes at all levels are great. The USAF, as the military service which stewards national military spacepower, could be given the concomitant responsibility and authority to effectively organize, train and equip the nation's space forces. How could the US Aerospace Force pursue this responsibility?

First, as the nation's military spacepower steward, the USAF could be given the organize, train, and equip responsibilities and authorities currently associated with various national agencies. Like USSPACECOM could integrate all national agencies' spacepower planning and execution functions, so too the USAF could take over all national agencies' military spacepower-associated organize, train, and equip responsibilities and authorities.

This is obviously a giant leap in faith. However, if the USAF is to be credible in its stewardship of national military space capabilities, it should be given the appropriate responsibility and authority.

A stark example of this is the US Army's push to develop, deploy, and operate a kinetic energy anti-satellite system (KE-ASAT). Why should the nation's ground force be spending time, energy, money, and effort developing and operating a space control system? Space control is as vital to space and terrestrial operations as air control (air superiority and supremacy) is to all other terrestrial military operations. The nation's aerospace service should be the one most concerned with providing both air and space control capability -- yet another service has deemed it appropriate to do so on its own.

Second, the USAF could divest its spacepower of fringe-related, and in many instances artificially associated, missions which detract from its evolution as a fully functional spacepower. It seems advantageous for spacepower evolution to not be hobbled with artificially-related missions and functions, as the US Army stifled airpower's evolution by tying it to reconnaissance and intelligence gathering as its only raison d'être. Like airpower, spacepower is so much more than merely seeing what's over the other side of the hill and reporting on it. Care should be taken for history not to repeat itself by allowing such mission marginalization to impede the full exploitation of the medium. The USAF can ensure space is a fully engaged subset of the aerospace equation, and handle its organization and missions just as it does its airpower organizations and missions.

While space obviously contributes greatly to these capabilities today (reconnaissance and surveillance), they are not the reason spacepower will advance in the future. Organizationally structuring military space to fundamentally support only these missions detracts from the pursuit of spacepower's full potential.

Intelligence is a good example. Intelligence, that is the gathering, interpreting and dissemination of data, is a mission -- it is not an environment of warfare like land, sea, air and space are. While space assets contribute greatly to the intelligence mission (just as land, sea and air assets do, as well), spacepower does not exist to merely gather intelligence data. While some intelligence professionals would differ, claiming that it does is akin to saying airpower primarily exists for the same reason because of the existence of the U-2, and formerly the RF-4, as well as SR-71 (and air platforms all the way back to the Wright Flyer).

That said, the nation's premier space-oriented intelligence gathering organization, the National Reconnaissance Office (NRO) seems ripe for having it's organize, train, and equip space function absorbed into the Aerospace Force. After all, when all is said and done, the NRO is really yet another DoD space force.[5] Many efficiencies could be realized, including minimizing excessive and redundant ISR capabilities (though a certain amount of redundancy is good and should be maintained), personnel usage (since the NRO uses a large amount of USAF personnel), and space lift/on-orbit support operations.

In short, such an absorption could better "operationalize" space more effectively, by incorporating space intelligence assets into mainstream military space operations.

Information operations (IO) is another good example. Tying this mission directly to space, as is occurring with the recent change to the SecDef's Unified Command Plan (UCP) assigning USCINCSPACE the computer defense and attack missions, and has been discussed within USAF circles, also would seem to hinder the advancement of military spacepower.

Even Congress seems concerned with this trend. According to *Space Business News*, 15 March 2000, "Congressional officials are urging the DoD to invest much more effort in developing innovative space warfare concepts -- concepts that more fully exploit space for national security purposes." In this same article, Senator Wayne Allard (R-CO) pointed out that "DoD currently tends to treat space as an information medium rather than a power projection medium."

While components of the IO mission are obviously related to space, and should be within military space's purview of operations, the IO mission is much broader and affected by all services' assets. To tie it directly and completely to the military space organization may detract from the long-term development and capabilities of both.

That said, where these missions can best be dealt with via space assets, USSPACECOM could be the planning and execution organization, and the US Aerospace Force (under the auspices of Space Combat Command [SCC]) could be the organize, train, and equip organization. However, to vest space organizations with their almost complete responsibility could be perceived as turning a blind eye toward evolving the full potential of spacepower.

Third, not only could the USAF be assigned all national agencies' military space organize, train, and equip responsibilities and authorities, it could also be assigned the organize, train, and equip functions associated with all spacepower missions -- space control, space force application, space force support, and space force enhancement.[6]

From an organize and train standpoint, the USAF could organize itself to conduct all these space missions (see figure two). Within SCC, three operational space wings could exist: the "XX" Space Combat Wing, the "XX" Space Force Enhancement Wing, and the "XX" Space Force Support Wing.

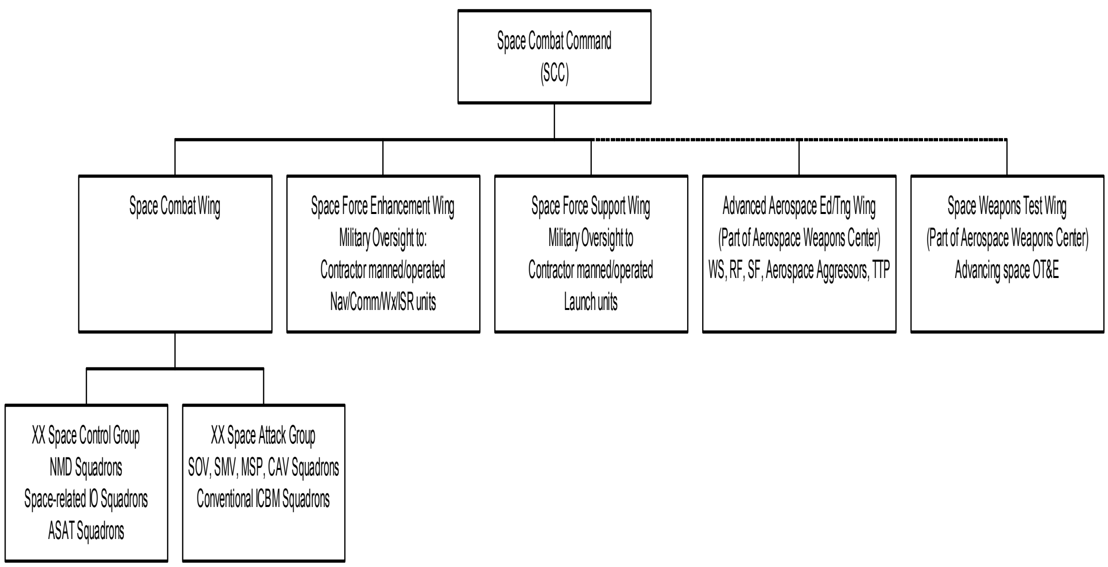

Figure Two: Space Combat Command Organization

A fourth wing could exist to conduct test and evaluation of space systems. A fifth wing could exist as a bridge between the air and space sides of the Aerospace Force, and be a wing manned by space, air, and aerospace (see last chapter) personnel.

The "XX" Space Combat Wing could have two subordinate groups; the "XX" Space Control Group, and the "XX" Space Attack (force application) Group. Each of these groups could have three subordinate squadrons. The space control squadrons could conduct the NMD, ASAT, and space-related IO missions. The space attack squadrons would operate (either remotely or on-board) the on-orbit or trans-orbit force application technologies (nearest term examples include SOV/SMV/MSP/CAV technologies).

The "XX" Space Force Enhancement Wing would be group sized, its mission being to provide *military oversight* to contractor-manned space-based navigation, communication, weather and intelligence, surveillance, and reconnaissance (ISR) units.

The "XX" Space Forces Support Wing could also be group sized, and provide the same oversight to space launch (EELV, SOV/MSP) units. Most notable, both of these wings would be manned primarily by contractor personnel who are expert in conducting these force enhancement missions. The fiscal advantages of this manning scheme are discussed in the next chapter.

The fourth space wing is associated with another re-organization concept -- combining the Air Warfare Center and the Space Warfare Center (SWC) into the Aerospace Warfare Center.[7] In the near term, it would better integrate space support to air operations, while in the longer term shift current thoughts on "space as support only" to "space for direct effect" thinking. The Aerospace Warfare Center would have three subordinate wings.

The "XX" Advanced Aerospace Education and Training Wing could combine all the operations the USAF currently employs to provide advanced training to all of its operators. This is where the USAF Weapons School, Red Flag, and advanced operational aerospace training and tactics development currently provided by the SWC and AWC would operate (including the Aerospace Aggressor Group). Additionally, this wing would conduct advanced space-unique space control and attack operational training at its Space Flag site (much like electronic-specific advanced warfare training is conducted today under the auspices of Green Flag, this site could be either co-located or geographically separated from the Red Flag training center). Obviously, advanced, terrestrially-related space control and attack operational training would be conducted under the auspices of Red Flag.

A vital component within this wing would be the Aerospace Aggressor Group. This group could have two subordinate squadrons -- an Air Aggressor Squadron and a Space Aggressor Squadron.[8] Both would be used to conduct professional and realistic threat training within, through, and between their respective operational media.

Space Aggressors would be instrumental in valid and realistic operational training and evaluation of space wings. Additionally, their services would be advantageously exploited at all Flag exercises and Aerospace Force spinup training, as well as in force experimentation efforts.

National policy seems to be coming to grips with such a need. Secretary Cohen, in his 8 February 2000 testimony to the Senate Armed Services Committee hearing on the FY 01 Defense Budget, said, "…so, as we become more and more dependent upon technology, we also have to spend more and more to protect that technology…"

The second subordinate wing to the Aerospace Warfare Center could be the "XX" Air Weapons Testing Wing. Much like the 53d Wing today, its mission would be to conduct operational test and evaluation of pending air systems and techniques.

The "XX" Space Weapons Testing Wing could be the third wing. It would conduct operational test and evaluation of advancing space combat systems and techniques. Both of these wings would coordinate with each other on integrated aerospace capabilities as appropriate, with project lead/support decisions made by the Center.

This Center would be a hybrid in that it would straddle two subordinate US Aerospace Force commands -- Air Combat Command and Space Combat Command. This, however, is not without precedent. Today, the USAF Doctrine Center is such an entity and answers to the US Air Force Chief of Staff. The Aerospace Warfare Center would answer to the US Aerospace Force Chief of Staff.

Though eye-opening, this consolidation, and attendant reorganization could decrease overhead, as well as contribute to continuity and coordination of the aerospace mission. In the longer term, it would also contribute to advancing spacepower by instilling the "bomb-dropping, killer" instinct within the space operator ranks. Airmen would better understand space. Spacemen would better understand air. Aerospacemen would result. As this transition occurred, the US Aerospace Force's mission to organize, train and equip the nation's aerospace force could be more effectively realized.

Conclusion:

As with advancing airpower capabilities in the 1920s through 40s, many organizational changes are possible to more effectively steward advancing spacepower capabilities. These opportunities exist at the national, DoD/joint, as well as service levels. Some will be relatively easy to incorporate, while others would be a bit more problematic.

At the national level, the US seems to have a quagmired space-related organizational complexity. National policy makers calling for better military stewardship of space could take it upon themselves to, first, minimize the number of national space-related agencies, and then streamline the lines of control of those remaining. A central national office could be appointed to manage national spacepower priorities.

At the DoD/joint level, military space components could be streamlined, decreasing span of control and duplication problems. The DoD, joint staff and CINC staffs should reflect the same amount of space expertise as they do today with air, land, and sea expertise. Happily, this seems to be occurring -- if slowly. Unified commands -- with US Aerospace Force expertise and guidance -- could also review the near-term advantages of a Joint Forces Space Component Commander.

The unified command responsible for planning and executing US space forces should have the complete capability to do so. It seems appropriate that the four military space missions of control, force application, support and enhancement should be the unique responsibility and authority of USCINCSPACE to plan and execute.

At the service level, many opportunities present themselves to the USAF, considering it is granted authority to change. First, the US Aerospace Force could be given the space-related organize, train and equip responsibilities and authorities of all the various national and DoD agencies currently dabbling in military space activities. If the USAF is to be a credible steward of the nation's space capabilities, it should have the appropriate span of control over all military space organize, train, and equip functions.

Second, the USAF could divest its space organization of fringe-related, and in many cases artificially associated, missions which detract from its evolution toward more advanced spacepower capabilities. The space aspects of intelligence and information operations should be integrated (e.g. absorbing NRO space-related organize, train and equip responsibilities and authorities into USAF), while their overall functions and missions should not obfuscate advancing military spacepower capabilities.

Third, the four military space missions should be the US Aerospace Force's own to organize, train, and equip for. Within SCC, there could be three space wings. One each for space combat (control and application), force enhancement and space force support.

Within the space combat wing, there would be two subordinate groups. Between them, the space control group's subordinate NMD, ASAT and space-related IO squadrons would conduct all military space control missions. Within the space attack (force application) group, three space attack squadrons would operate (either remotely or on-board) the on-orbit or trans-orbit force application technologies as they come on line.

The group-sized space force enhancement wing would provide military oversight to contractor manned space-based navigation, communication, weather and ISR units. The group-sized space forces support sing would do the same for contractor-manned space lift and on-orbit support units.

The reorganization of the Air Warfare Center and the Space Warfare Center into the Aerospace Warfare Center would have three subordinate wings. In the near term, this reorganization would better integrate space support to air operations, while in the long term shifting current thought from "space as support" to "space as direct effect."

The Advanced Aerospace Education and Training Wing would train all advanced operational aerospace operations. The WS, Red Flag, Space Flag, tactics development, as well as advanced space operations courses (currently taught by the SWC) would all reside here. Space Flag would conduct advanced space-unique space combat training.

Red Flag would conduct all advanced, terrestrially-related, aerospace training (including advanced terrestrially-related space control and force application capabilities). Additionally, the Aerospace Aggressor Group would effectively reside within this wing.

The Aerospace Warfare Center's second wing would conduct air operational test and evaluation. The Center's third wing would conduct space operational test and evaluation. Both would coordinate with each other on integrated aerospace capabilities as appropriate, with project lead/support decisions made by the Center.

As a hybrid Center, made up of personnel and equipment associated with the Aerospace Force's two largest commands -- ACC and SCC -- the Center would answer to the Aerospace Force Chief of Staff. This would hinder the infestation of air or space parochialisms from either combat command. Precedent for this line-of-authority exists today with the USAF Doctrine Center.

It seems all of these organizational shifts would be fundamental to advancing national spacepower. Some would be easier to realize than others -- but all would seemingly contribute to advancing military spacepower capabilities. Closely associated with these organizational shifts are possible fiscal authority shifts -- discussed in the next chapter.

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[1] Dana Johnson, et al. "Integrating USAF Space Operations -- A Framework to Explore the Evolution of Air and Spacepower." RAND. June 1998.
[2] "Comments on Expeditionary Force Experiment 98." General Charles Horner, USAF (ret), December 1998., p.4.
[3] Ibid.
[4] "Special Report: Facing Up to the Space Problem." Air Force Association, 1 Nov 1994. They list the following thirteen national agencies as impacting space operations: NASA, NOAA, BMDO, NRO, CIA, NSA, DISA, DEFSMAC, AFTAC, DoD, DoC, DoT, DoI, National Science Foundation, and White House OSTP.
[5] Discussion between the author and Lt Gen Lance Lord, AU/CC and a senior space operator, Maxwell AFB, Alabama, 28 October 1999.
[6] A cursory review of recent articles suggests the various military space missions are being piecemealed among the services, as well as DoD agencies. From the Army testing ASAT lasers and vying for portions

of national missile defense, to the Navy flying its own satellites, and the existence of BMDO, NRO, etc. the unity of command vis-à-vis military space missions is weak to non-existent.

[7] These ideas grew out of a concept originally conceptualized between Lt Col Warner "Bear" Trest and the author over many nights in the Nellis AFB Officer's Club, while Col Trest was the Director of the Aerospace Integration Center, and the author was the Commander of the WS Space Division. The bar napkin has since disappeared, but the basic concept remains and is expanded in this argument.

[8] The Space Warfare Center has been out in front of an effort to establish a fledgling space aggressor unit. Initially visualized as a small unit that simply acquired commercially available imagery to demonstrate US vulnerability to widely-available imagery, it has rightfully expanded into more operationally-oriented space control/counter space considerations.

Chapter Nine

Fiscal Issues

The Air Force budget has to change…I'm not talking about one or two percent…What I am talking about is [a] concerted effort [to] change the Air Force budget to prepare for tomorrow's threats today.
-- General Howell Estes III, former CINCSPACE

We need to foster innovation now; we are proceeding slower now than our best performance in the 1920s -- it doesn't have to be that way.
-- Andrew Marshall, OSD/NA

Its not an issue of commitment. Its an issue of resources.
-- General Richard Myers, USCINCSPACE

Overview:

The United States could benefit from fully capable spacepower for all of the reasons noted in Part I -- most notably its inherent political and military flexibility. The nation could possibly realize greater spacepower capabilities via many of the changes proposed so far in Part II. Fundamental changes in national, DoD/joint, and service perspectives, as well as organizations, seem necessary harbingers to more capable spacepower.

However, in the final analysis, the nation, DoD and the USAF can collectively change their thinking about spacepower, they can also all institute broad organizational changes to herald its advance, but without definitive changes to fiscal priorities, all of their efforts would be for naught. *Money makes the world go round -- it also makes things go around the world*. As the old saying goes, "No bucks, no Buck Rogers."[1]

With this in mind, this chapter proposes possible shifts in national, DoD/joint, as well as USAF fiscal issues. Again, this analysis is by no means all encompassing -- there are many other issues involved -- but issues discussed herein seem fundamental to advancing military spacepower capabilities.

From a national perspective, notice should be taken of the value of commercial/civil/military partnerships when dealing with costly space programs. Many opportunities exist to gain economies of scale by combining similar capabilities from a national perspective. Most notable among these, from a military spacepower perspective, are force enhancement and force support capabilities.

A second major issue vis-à-vis national fiscal priorities deals with funding some of the organizational changes suggested in the last chapter. As national agencies' military space-oriented organize, train, and equip responsibilities and authorities are coalesced under the United States Aerospace Force, their associated budget authority should also flow.

A third major national issue is increased overall funding for military space related activities. Happily, certain recent occurrences indicate this trend may be initiated.

From a DoD/joint perspective, and given the perspective and organizational shifts proposed in the last two chapters, as the Aerospace Force provides all military space capabilities to the services, and many DoD agencies, this service should be paid for by those receiving it. It seems appropriate and fair for users to pay for services rendered. To a certain extent (but by no means completely), this could be accomplished via the next proposal -- when transferring other services' or DoD agencies' space-related organize, train, and equip functions to the USAF, those services' and agencies' space-oriented funding could be transferred along, as well.

Many fiscal change opportunities present themselves within the USAF -- or US Aerospace Force. As the purveyor of the nation's military aerospace power, a central organization within the USAF could be charged with the non-parochial analysis of air and space mission/technology tradeoffs. Second, but associated with this first proposal, a USAF roadmap could be established to program currently air-based aerospace missions to migrate to space (where and when operationally and politically appropriate). It could prioritize its budget to "integrate to migrate," and divest itself of passe, resource-hogging force structure. Third, but still associated with the first two proposals, force experimentation could be non-parochially pursued, with an eye toward advancing technologies and capabilities. A fourth issue deals with the broad readiness versus modernization debate, and analyzes how it is affected by today's limited budget and increased worldwide US military commitments.

All of these issues are summed up in the final discussion about the advantages of a net increase in the Aerospace Force's budget. Additive effects of mission disvestiture, mission absorption, space budget fencing, and reallocation of DoD budget priorities are discussed. Additionally, possible decreases in space mission costs are analyzed. In the end, the availability and decisions made regarding resources will determine the reality of fully capable military spacepower.

National Fiscal Issues:

Space operations, and attendant research and development requirements, are costly for all space "players." As discussed earlier in this paper, international and national entities are rapidly migrating many capabilities to space. US commercial space ventures, as well as civil and military space operations are increasing quickly. It seems a certain economy of scale can be realized by partnering space capabilities when appropriate.

Additionally, as national agencies' space-related missions, as well as organize, train and equip functions, migrate to DoD and the USAF (as proposed in the last chapter) it seems appropriate for their funding lines to migrate, as well. In the aggregate, its reasonable to assume savings could be realized in this transformation of responsibility and fiscal authority.

Finally, it seems to make sense that if this nation is to realize advanced spacepower capabilities, it should realistically fund research and development of basic and advanced technologies. The DoD and USAF could then invest these national funds wisely to achieve the national will.

Fiscal Realities and Military-Civilian Space Reliance

The future dictates a close relationship between military space requirements and civil space resources, including both operational and research and development realities.[2] Many military space functions closely parallel civil functions. Where these are evident, they should be exploited to save costs to both sectors. That said, certain functions will continue to be the sole purview of military space.

Joint military - civilian space functions include weather, navigation, communications, earth resources, lift, orbit transfer, and tracking and control systems. Integrating many aspects of these systems to serve both military and civil customers -- while maintaining military oversight as discussed in the last chapter -- could realize massive savings in fiscal requirements to both sectors. Near term examples of probable and possible joint projects follow.

Space weather capabilities should become more economical as the Defense Meteorological Satellite Program (DMSP) and the National Oceanic and Atmospheric Agency (NOAA) combines. The turnover of DMSP responsibilities to NOAA should decrease military investment in weather reconnaissance. Additional savings can be realized by replacing the purchase of next generation military weather satellites with purchasing such data from reliable national sources. Commercial market competition could allow purchase-what-you-need ability. While this seems easy and effective, care must be taken to ensure on demand military capability.

Space navigation systems can be streamlined, as well. GPS could be assigned to the Department of Commerce or Transportation, since demand for such data is well beyond the purview of strictly DoD functions. Alternatively, current GPS systems could be sold to corporations on a cash plus percentage basis, thereby raising cash for additional space resources or developments. Military users could purchase required services as needed. Military priority and accuracy would need to be protected -- a mission of the Space Force Enhancement Wing, as discussed in the last chapter. An associated suggestion has been made for large constellations of other types of satellites to repeat navigation signals for redundant worldwide coverage.

Space communications systems are proliferating rapidly. Microsoft Corporation's Bill Gates plans to exponentially expand such capability with his 840 Teledesic satellite constellation. Teledesic's goal is to bring the information superhighway in all its glory to even the most remote reaches of the globe by the end of the century.[3]

Very high resolution, hyper-spectral satellite capabilities are almost a reality. AFSPACECOM sources put it within reach within a decade. Commercial enterprises will offer complete, competitive, fast response global coverage, thereby decreasing DoD demands to build and field such systems. Additionally, research for such capabilities is being increasingly funded by the commercial sector due to potential profit.

Lift and orbit transfer may be solved commercially, driven by commercial needs to access space. If such a robust system develops, there would be no need to maintain the military's satellite - booster - operator system. Such a commercial system could make launch-on-demand more realistic due to launch quantity and competitive price forces.

An associated issue is operating and maintaining US launch infrastructure and ranges. There is great potential for partnership and cost savings in this sector. On 8 February 2000, the

National Security Council and the Office of Science and Technology Policy released their report "The Future Management and Use of the US Space Launch Bases and Ranges." This report included immediate steps to improve operations at facilities -- including a recommendation to allow the use of private sector funding "for the continual maintenance and modernization of the space launch ranges and bases to meet national needs for space transportation."[4]

The report recommends overhauling the excess capacity rule "which limits government's ability to accommodate growing commercial requirements." It also addresses potential radical shifts in responsibility of facilities management, safety, regulation, and technology development.

Tracking and control of commercial satellites could be done commercially, with inter-corporation commonality and cost sharing decreasing commercial risk. DoD and NASA could follow corporate footsteps for military satellites, with USSPACECOM controlling all military assets. Alternatively, both corporate and military satellites could be controlled by an integrated national tracking and control system, thereby sharing costs among all users.

The bottom line of this approach to joint military - civil space exploitation is that the huge commercial market would likely dwarf the military needs in space, thereby driving down DoD space costs.[5] However, the military would need to maintain certain *realistic*[6] standards across the marketplace to ensure its ability to use the systems.

Care must be taken to ensure a capability to closely control these functions in the interest of national security. There are two aspects of this concern. First, the military must have unobstructed and complete access capability in the event of a national emergency, much like the current Civil Reserve Air Fleet concept. For example, contracts could be drawn with civil communication satellite companies to enable daily dual use, and emergency complete use, of the companies' orbiting resources. Second, the US can increase its security by increasing foreign customer dependence on these US-provided systems. For example, provide GPS data day-to-day at such a price to monopolize the worldwide satellite navigation market, thereby ensuring control of access to such data in the event of a national emergency.

The space functions that will continue to be the sole purview of the US military include certain surveillance and reconnaissance capabilities, missile warning and defense, most-secure communications capabilities, resource protection, command and control warfare, attack, and space system negation capabilities. Certain near term requirements within these mission areas follow.

Regarding surveillance and reconnaissance, tactical space ELINT/IMINT (TACSATS) for earth observation is needed, unless the National Reconnaissance Office (NRO) can ensure timely and sufficient service. Real-time data fusion of multiple sensor inputs is presently being worked. Accurate geolocation of threats in time and space is needed for prompt preemptive military action.

Space surveillance requirements include providing space traffic control to allow knowledge and control of all space resources, including civil. Resources could be saved by allowing commercial, university, and technical center feeds into a military space traffic control database to decrease overall collection requirements. Associated missile warning and defense requirements include surveillance/tip off/queuing remaining within the military domain for purposes of speed, accuracy and preemptive capabilities.

Regarding most-secure communications capabilities, commercial sources will have corporate secure capabilities. This seems acceptable. In fact, more “routine” military secure transmission requirements could be met more cheaply this way. However, the military should retain most-secure capability for NCA and CINCs' communications, highest priority national security communications, and data links for most-lethal national assets.

Resource protection remains a military consideration. Hardening of sensors, receivers and transmitters is required to maintain the information edge on future threats (close hold data) and to realize the extent of proliferation of high threats (RF, HPM, Lasers).

Another singular military requirement is a large space maneuverability capability for coverage, evasion, mission responsiveness and flexibility. Such a capability may be on-board a satellite, or may use MSP-associated technology. However, it is not currently relevant to commercial users, so they likely would not primarily fund such research and development.

Attack and space system negation issues include KE and DE force application capabilities, as well as advanced weapons for permanent or temporary, lethal or non-lethal effects. In the age of knowledge warfare, such capability could give the US a selective attack option on enemy or third party information suppliers.

National Funding of Organizational Consolidation in the USAF:

As discussed in the last chapter, certain economies of scale can be realized by consolidating the space-related missions of the myriad of national and DoD agencies under the USAF. Former CSAF General Tony McPeak has been quoted as saying, "I've always regarded space as the legitimate domain of the Air Force. I think it's a tragic waste of national resources that space is not consolidated within the Air Force."[7]

As noted previously, there are many national organizations with tasks directly related to military space operations. Chapter Eight discussed the advantages of migrating these organizations' military space taskings to the USAF. As noted, this migration would realize cost savings from decreased duplications of effort, as well as economies of scale.

Though funds would be saved in the aggregate, the USAF would require increased funding to accomplish the entire military space mission. It seems logical that as these organizations' military space missions migrated to the USAF, so to should the appropriate apportionment of their budgets related to military space activities. This increased USAF funding for space activities could then be used to advance military spacepower capabilities, vice being lost in duplicative space support efforts and to lost opportunities at realizing economies of scale.

Bottom line is that as national agencies' military space-related organize, train and equip functions migrate to the Aerospace Force, their related budgetary authority should also flow. Though, on the surface, this seems a zero-sum exercise, the savings realized from less duplication of effort, as well as increased economies of scale, would seem to result in increased national military spacepower capabilities.

Recent National Military Space Priorities:

Though funding a fragmented military space architecture, it seems Congress is more than willing to increase funding for military space-related activities -- and is demonstrating a keen interest in advanced military space capabilities. What follows is a short summary of the military space-related results of the FY 00 Defense Authorization Conference.[8]

a. Section 213: Senate bill provided for an increase of $25 million for micro-satellite technology development. House bill provided for an increase in $10 million.
b. Section 214: Senate bill provided for an increase of $10 million for space control technology development and $41 million for U.S. Army space control technology development. House bill provided for $5 million and $10 million, respectively.

c. Section 215: Senate bill provided for an increase of $35 million for the development and acquisition of an Air Force X-40 Space Maneuver Vehicle (SMV). House receded with an amendment for a $25 million increase.

d. Section 231: Authorize SBIRS Low funding of $229 million, and provide authority for realizing most efficient and effective development and deployment of SBIRS Low program.

e. Section 234: Senate bill called for establishing a structure for the Space Based Laser program, including a program baseline for an integrated flight experiment (IFX). The conferees called for the SecAF, in coordination with BMDO, to begin design of the SBL test facility and authorized $10 million for this purpose. Interestingly, the conferees stated they did not believe the Air Force's schedule for a 2012 IFX launch was not sufficiently aggressive.

f. Section 237: The Senate bill funded National Missile Defense at $836.5 million. The House bill increased this amount by $10 million.

g. Section 251: Senate bill called for the SecDef to develop a unified DoD laser master plan, as well as required the Secretary of the Army to initiate a development program for laser technologies, and authorized an increase in $20 million to carry out Army laser technology development program.

h. Section 1601: Senate bill required SecDef to develop a detailed guide for investment in space science and technology, and planning and development for space technology systems.

i. Section 1602: Contains a provision requiring the SecDef to prepare a report on U.S. military space policy, and current and projected U.S. efforts to fully exploit space in preparation for possible conflicts in 2010 and beyond.

j. Section 1603: House bill required SecDef to report on recent space launch failures.

k. Section 1604: House bill contained provision requiring a $7.3 million increase in operational funds for Air Force space launch facilities, as well as an associated report from the SecDef. Senate bill called just for the report.

l. Section 1621-1630: Senate bill contains a provision to establish a Commission to Assess United States National Security Space Management and Organization. This Commission will report on possibility of establishing a new major force space program for managing national security space funding and organization.

A stark example of Congress' interest in increased military space capabilities is a recent discussion between the SecDef, Secretary Cohen, and the Chairman of the Joint Chiefs of Staff, General Shelton, and members of the Senate Armed Services Committee, during testimony on DoD's FY01 budget. Particularly, this discussion demonstrates Congress' interest in space control capability -- a requirement for any kind of military space exploitation (as discussed in Part I of this thesis).

Senator Bob Smith led with a question to General Shelton. What follows is a portion of the applicable testimony:

> Sen Smith: General Shelton and Mr Secretary, am I correct in saying that you would agree that space control is an important asset for our war fighters, in that it denies the enemy the use of space? I think generally that is a correct statement. Just specifically, in a sentence or two, because I want to pursue this in the little time that I have. KE-ASAT, do you support it or not? General Shelton?
>
> General Shelton: I think, Senator, I'd like to provide an answer for the record to you on that. I need to go back and look at it.

Sen Smith: Alright. Mr Secretary, I don't mean to hammer you with a specific item out of the budget, in any terms of making it awkward for you. But it’s a particular source of frustration for me. And let me just leave you with the history and then you could provide the answer for the record.

We need about $37 million more over the next two years to complete a program that every year since 1993 President Clinton has tried to remove, and every year since 1993 I've successfully been able to keep the funding there for a program that everybody that I talk to tells me is important. And yet, this year, again, the Army hasn't spent the funds that we provided last year and they're reshuffling the program.

And let me just give you four or five examples of why its frustrating to me.

President Clinton got a letter from Mr Yeltsin in 1997 in which Yeltsin said: "Let me be frank with you, Mr President. We are alarmed by the US military's intention to develop a whole gamut of anti-satellite weapons programs. The aim is obvious -- to develop a capability to destroy space surveillance and control systems of other countries, including, of course, the Russian ones. That means the missile attack warning and surveillance systems that ensure the required transparency and, therefore, predictability and stability may be jeopardized."

Two months later, the President line item vetoed KE-ASAT, after it had passed Congress. He singled that out with only two other programs, both of which dealt with space assets.

What he could have said, if he had responded to Mr Yeltsin, "There was no intention to destroy your early warning satellites, Mr Yeltsin, but rather to protect US forces in the field against overhead surveillance. That's point one.

Point two, General Estes wrote a letter to you, General Shelton, in February of 1998, in which he said to you, KE-ASAT -- and this was after the veto -- this ground-launched interceptor will provide a limited strike capability against hostile satellites. In essence, KE-ASAT provides a near-term space control capability to comply with the national space policy direction to exploit space in the interest of national security, and went on to say it’s the nearest-term space control answer with the leas risk.

I mean, he was very emphatic. And yet again, subsequent to that…same budget, no KE-ASAT--and we could go on and on. Forty-six retired three and four star military officers sent a letter to President Clinton…in January of 1998, again prior to the budget,…there were some pretty heavy hitters on the list…and [their points were] ignored -- and again nothing was funded.

…And year after year, in spite of this technology, this program has been shelved. And as I say, I'm hitting you with a very specific issue here, but General, I urge you to take a look at this. There's a lot of discontent brewing over this. There's a lot of concern about national security from a lot of people you respect and would listen to, I think.

Again, these excerpts from the FY00 DoD Authorization Report -- as well as the SASC budget discussions -- seem to demonstrate two things, one disadvantageous, the other advantageous. First, the money and effort devoted to military space activities is fragmented among many various services and agencies within DoD. Second, the Congress is showing military space activities, including advanced military space capabilities, is rapidly becoming a national priority. The military must deal smartly with this reality.

DoD/Joint Fiscal Issues:

Per the perspective and organizational changes suggested for DoD in chapters seven and eight, respectively, it seems appropriate for there to be associated budgetary shifts made. First, as the proposed Aerospace Force could provide all military space capabilities for DoD and the joint warfighting CINCs, these services would have to be paid for by the organizations receiving the service. Much of this budgetary shift can be accomplished via transferring other services' and DoD agencies' military space-related fiscal authority to the proposed Aerospace Force.

Second, the Aerospace Force should be the sole military space agency that would fund, develop, operate and maintain any military space system or capability required via the JROC process. This standardized approach would go a long way to decreasing money and capability losses due to duplication of effort and lost opportunity cost due to economies of scale.

General Moorman, USAF (retired), spoke of this when at a National Press Club briefing in January 1999, he said:

> When I was on the JROC, I always believed that the country, not just the Air Force, but the country had far too much intelligence, surveillance, and reconnaissance (capability). But we had no way to do the trades to figure that out. The divestiture process is complicated, and it will require all services and help from the Office of Secretary of Defense and the Congress to really make progress.[9]

As an example of the amount of money involved in such a shift, what follows is a review of FY00 authorization for two space-related DoD agencies. While there are at least 13 such agencies and organizations, many associated funding lines were inaccessible for study due to classification levels. For example, many NRO and NSA space-related funding lines were beyond the classification level of this paper's analysis.

Therefore, the two largest DoD space-related organizations with unclassified budget lines -- BMDO and DISA -- are analyzed[10]. Note these numbers represent only "procurement" authority -- it is assumed research and development and other associated fiscal authority numbers would parallel those numbers presented here.

In the FY00 Defense-wide Procurement Program budget, BMDO is funded for four space systems. Theater missile defense systems account for $355.9 million, while national missile defense systems account for $781.4 million (programmed for FY 2001).

The same Program budget funds DISA FY00 procurement at a total of $116 million. $34.9 million of these monies fund systems directly related to military space activities.

Just from these two DoD agencies, $1172.2 million is spent on procuring military space related capabilities or systems. This fact does not seem to jibe with the fact that the USAF is the nation's aerospace force.

<u>USAF Fiscal Issues:</u>

It seems advantageous for this incongruancy to change. The USAF, or proposed Aerospace Force, should be properly funded to meet its stated mission of providing the U.S. with its military aerospace (air and space) power. With proper funding -- and the willingness to use it for its intended purpose -- the USAF can spend its money to integrate and migrate aerospace missions. With limited funding, and increased operational requirements, the USAF finds itself hard-pressed to meet funding requirements to further total aerospace integration and migration.

A recent discussion on the FY01 DoD budget between Secretary Cohen, Mr Lyn (the OSD Comptroller), and Senator Allard of the SASC highlights this limitation:[11]

Sen Allard: I also want to place a question on the airborne laser program cut. Just a few months ago, the Secretary of the Air Force certified that the airborne laser program was ready to move ahead. He made a quote, and I'd like to share that with you, "Its excellent progress has been made in all five areas. And in addition, the ABL program continues to meet or exceed every technical and programmatic milestone, and remains on costs and on-schedule."
And so, first, I'd like to know what the reasoning -- what there was behind the $91 million cut in fiscal year 2001, with a total of $670 million, which in essence could delay the program some eleven years and add over a billion dollars to the cost of the program
And second, it doesn't seem to make much sense to meet that when you have a program that's meeting and exceeding all its requirements, and is on budget and on schedule -- and apparently not too many programs can make that claim -- why we make this successful program a bill-payer, which may not be able to make the same claim. I wish you'd comment on that.

Secretary Cohen: Senator Allard, I think this is one of those determinations of working wit the Air Force, in terms of the allocations of resources; in terms of their highest priorities. The program is on-track; it does meet all requirements. But I believe the Air Force in its own internal deliberations made a number of trade-offs in terms of other programs that deserved somewhat higher priority.

Mr Lyn: The Air Force was stressed in a number of areas that had to make some reductions here to support some programs, otherwise. And I would just add -- put it in the context that the overall ballistic missile defense effort of the department actually is over the course of the FYDP is up to $3 billion -- both this year and over the whole course of the FYDP.

The Aerospace Force could realize certain benefits by changing its budgetary activities. First, it could standup a high-level office (e.g. answerable directly to CSAF) to conduct aerospace technology tradeoff analysis. This tradeoff analysis would result in force structure divesting decisions being made. Second, the Aerospace Force could "integrate to migrate."[12] The office just discussed would be instrumental in directing the force's mission integration and migration. Third, hard decisions could be made reference the ongoing readiness versus modernization debate. Present day realities and responsibilities should be wisely weighed with modernization opportunities to realize advanced spacepower capabilities while continuing to do the nation's daily military aerospace business. Last, and the real driver behind the entire discussion presented here, the USAF budget should increase in accordance with the reality that it accomplishes the nation's military business in the two most technologically costly military operating media -- air and space.

Single Aerospace Force Architect

As the USAF, or proposed Aerospace Force, is the service that accomplishes the nation's military business in the two most technology-costly military media, it could wisely conduct aerospace force structure tradeoffs (regardless of how much fiscal authority transfers with space mission transfers from other DoD agencies and organizations). This could be done by establishing a centralized office with relatively great authority to conduct aerospace technology tradeoff analysis -- ensuring opportunities to advance aerospace capabilities are not lost -- and are accomplished in as effective and efficient a way as possible. Most importantly, this office should go to great lengths to be as nonparochial as possible. Internal air *or* space power zealotry would negate the office's effectiveness.

The basic tradeoff analysis conducted by this office should be based on three main issues -- advancing technology capabilities, military operational utility, and national political will (associated with amending appropriate treaties). In other words, as technology allows more air missions to be conducted to, in, from, and through space, the operational efficacy of conducting these missions to, in, from, and through space could be determined. Obviously, assuming it is possible and smart to conduct these missions to, in, from, and through space, national political would have to exist to make it so.[13]

The decisions made by this office would significantly impact force structure. The ability of this office to determine best ways to divest the service of inefficient or less effective present or proposed future force structure would determine its success.

Integrate to Migrate

Such radical ideas out of this "architect" office, associated with tradeoff decisions and the political "go ahead" to conduct advanced spacepower missions, would lead the Aerospace Force down the road of integrating current air and space capabilities to realize eventual migration of many missions into, from, and through space. This is the path by which the United States Air Force of today becomes the United States Aerospace Force.

Initially, it seems reasonable to assume intelligence/surveillance/reconnaissance (ISR), long haul communications, navigation, and weather missions would ever-more completely migrate to space. These missions are currently the most integrated air and space missions.

Presently, targeting and cueing functions are becoming ever more integrated between air and space capabilities. It seems reasonable to assume these missions may be the next to migrate into space.

Global logistics capabilities are becoming increasingly integrated as space capabilities to support rapid global mobility increase. Advances in all space force enhancement missions[14], coupled with increased ability to effectively and efficiently conduct space lift missions, should lead the way for a certain amount of the global logistics mission to migrate into space, as well.

Obviously, as more and more missions become integrated, and continue to migrate into space (where and when technologically and operationally feasible), the mission of space control becomes more important. Consequently, the Aerospace Force could simultaneously develop even greater abilities to protect its, as well as allied, civil, and commercial space capabilities. Congress and the USAF realize this reality and have both pledged increased funding for space control.[15]

The final aerospace mission area to migrate into space will probably be force application.[16] This may naturally occur as other missions become fully integrated and finally migrate into space, demonstrating operational efficiencies and political flexibility in so doing. Force application in, from, and through space may not be as big a "hurdle" as many now believe. It will be a reasonable and common-sensical evolution of the Aerospace Force's raison d'être global attack mission. The ability to apply force globally, anywhere, at any time, would allow the U.S. military to "effect" adversaries in ways previously only dreamed of -- and put a very powerful arrow into US political leaders' quiver.

All of this would only be possible given the ability of the Aerospace Force to non-parochially make technology tradeoff decisions to conduct its many missions. Additionally, increased force experimentation would be required to more rapidly advance these capabilities.

A good agar for this is the current Joint Expeditionary Force Experiments (JEFX) series of experiments currently being conducted periodically by the USAF, in coordination with other services. With enough foresight, this experimental "structure" is well placed to allow for "out of the box" thinking to advance mission integration and migration.

Obviously, modernization such as that described here is not without costs to current operations. Readiness versus modernization issues should always be considered from the outset when making the kind of analyses the "architect" office will be charged with.

Readiness versus Modernization

Today's USAF is tasked with executing operations all over the world, from strike operations, to stopping a Balkan despot, to humanitarian relief efforts in Central America, to continuing to limit aggression of various players around the world. It does all of this with a budget and force structure drastically reduced from its 1980s highs, as well as a declining ability to maintain personnel strength within vital specialties, as well as coping with an aging infrastructure.

At the same time, it seems appropriate the USAF looks to the future. Difficult decisions may have to be made between modernizing its forces to meet the challenges and potential of the Twenty-first Century, while maintaining its daily identity as the world's best aerospace force.

Unfortunately, it seems its budget, combined with its worldwide taskings, has not allowed the USAF to more aggressively pursue advanced spacepower capabilities. In attempts to stop recent criticisms about its seeming inability or unwillingness to more aggressively pursuit spacepower, various USAF officials have made the point the USAF's space budget is increasing while its budget to support aviation related missions has declined.

For example, the SecAF has been quoted as saying the USAF's overall budget has declined 40% while its space budget has risen by 3%.[17] While on the face of it, this seems noteworthy, an analysis of the numbers leaves room for interpretation. From a macro viewpoint, the space budget has always been orders of magnitude less than the "flying" budget within the USAF, so a 3% increase of what was already a relatively small number is still a small number. Additionally, the overall "flying" force structure has dwindled considerably -- well past 50% of its mid-1980s highs. Therefore, a 40% decrease seems actually a little low.

A look at the raw numbers tells the story better. They actually show a net decrease in USAF expenditure on the acquisition of space systems between 1998 and 2000, and a net increase in expenditures (by percentage) on air systems. The data in the following table is culled from the Department of Defense Budget for Fiscal Years 2000/2001 ("Program Acquisition Cost by Weapon System").

	1998	1999	2000
Total Air & Space System Expenditure	8162.3	9781.9	10492.0
Total Air System Expenditure	5901.9	7112.8	8245.7
"TacAir"	2294.4	2572.3	3515.1
Total Space System Expenditure	2260.4	2669.1	2246.3
% of Air System Expenditure	72.3	72.8	79.6
% of Space System Expenditure	27.69	27.2	21.4

Figure One: USAF Gross Expenditure on Weapons Systems (Millions $)[18]

The USAF's research, development, testing, and evaluation (RDT&E) budget tells a different story, and may be what the SecAF was referring to. The raw numbers from the DoD Budget for Fiscal Years 2000/2001 ("RDT&E Programs [R-1]") demonstrate that space as part of the total Advanced Technology Development (ATD) portion of the RDT&E Budget accounts for 43.3% between the years 1998-2001.

Total Air ATD	2,243,104
Total Space ATD	1,916,082
Space Control-related ATD	27,115
Space Force Application-related ATD	34,885

Figure Two: USAF Expenditure on Air and Space Advanced Technology Development (Thousands $)[19]

However, a closer look seems to show a distressing trend about more aggressive spacepower research. Most of the space-ATD budget is earmarked for force enhancement missions, while space control only garners 1.4% of the space-dedicated portion of the budget, and space force application only garners 1.8%.[20] Its distressing that even with the limited amount of dollars the USAF has to put toward advanced spacepower development, most of it seems to be being spent on improving the "support" ability of spacepower.

With all of that said, a recent article in *Defense Daily* points to a shift in USAF emphasis in technology development. On pages ten and eleven of the 14 Jan 2000 issue, the verbiage points toward the USAF science and technology (S&T) funding getting a significant boost in the DoD's FY01 budget request. USAF Lt Gen Stephen Plummer, the Principal Deputy Assistant Secretary of the Air Force for Acquisition, is quoted as saying, "We are striving hard to reverse the declining S&T budget and anticipate a significant real increase for S&T in fiscal year 01. We are working hard to raise it further in the years beyond that."

The article goes on to discuss the friction between readiness and modernization. Additionally, it points out the USAF is aggressively insisting on space system inclusion in the Defense Technical Objectives from 1999 and beyond.

> The Air Force said in the statement that it "agrees that the decline in Air Force S&T spending must be reversed. Further, an increased overall budget would be the single most important factor in accelerating the strengthening of the Air Force S&T program." One of the factors complicating the S&T budget for all the services is the emphasis on fielding current systems. Defense Technical Objectives for 1998, which identify technological areas for development or demonstration, did not include space, but the Air Force insisted on their inclusion in the 1999 Objectives, according to a report released this month by the Air Force Association, "Shortchanging the Future: Air Force Research and Development Demands Investment." "Space is to comprise 20 percent more of the service's TOA over the next 20 years as the expense of other programs," the report says.
>
> The AFA study decried the move by the service to return Space Based Laser and Discoverer II space radar programs to the S&T budget line from engineering manufacturing and development and requiring the S&T budget to absorb the cost -- $94 million in FY00 and $131 million in FY01 and more in the years of the FYDP. "Many existing S&T programs -- including other space projects -- were badly damaged while nearly $3 billion was freed up for non-R&D expenses over the coming FYDP period," according to the report.

Obviously, the USAF is attempting to deal with the dilemma of readiness versus modernization. It seems to have realized the need to more aggressively pursue spacepower. The tight rope involves spending scarce money for the most potential advantage. It seems advantageous to spend at least as many research and development dollars on space control and space force application as it does on force enhancement, if not more. Without that kind of investment, the USAF's realization of its destiny of being the nation's Aerospace Force may be a long time in coming.

Additionally, perceptions are often deemed reality. It seems beneficial for the USAF to be seen aggressively pursuing *both* the air and space technologies that makes it the nation's aerospace force.[21] Just in the past six months, the USAF has weathered cuts to three of its most advanced spacepower systems -- Discoverer II space based radar technology demonstrator, Space Based Infrared Radar system, and the Military Spaceplane program. All of this occurred with the same ax that temporarily felled the USAF's F-22 fighter program. Interestingly, there was much dissent and decry about the F-22 slight (for very good reason), but there was hardly any public institutional comment about the multiple and important space programs which were also axed. In this era of limited DoD fiscal authority, it may be to the USAF's advantage to be publicly seen as equitably fighting for all of its aerospace systems.

Overall USAF Budgetary Authority Increase

One of the issues in the USAF's fight for all of its air and space systems and technologies is the reality that air and space are the two most high technology-cost media that any military service operates in. In short, not only must the USAF wisely proportion the money it invests in aerospace technologies, it should also be given the proportional DoD budgetary authority to field technologies in these two high cost military operating media.

Two ways of doing this have already been suggested in this paper. The additive effects to the overall USAF budget of absorbing all DoD space-related missions and budgets could go a long way to remedying this situation. Additionally, the additive effects of divesting other USAF resources would also help.

However, the largest share of appropriate DoD budget dollars could come from increasing the overall DoD budget, as well as from re-sizing the pieces doled out to the services in the overall DoD budget. The services could be budgeted to effectively maintain readiness and modernize forces designed for their specific operational media. The Quadrennial Defense Review effort should realistically plan for the nation's military needs. No longer should the "Goldilocks Rule" be applied to DoD parceling of service budgetary authority.[22]

A look at the DoD's TOA by service shows a disturbing trend. As stated, the USAF is called upon to fund operations in the two highest cost military operating media, yet the numbers reflect actual real growth as a percentage of the other services as at or below the other services through FY05. In other words, it seems the DoD will continue to fund the services at about the same rate, regardless of the costs of advancing technology in the service's respective media.

	FY01	FY02	FY03	FY04	FY05	Total Real Growth
Army	3.3	0.4	1.0	0.3	1.4	6.4
Navy	6.8	-4.8	1.7	0.5	1.5	5.7
Air Force	4.4	-0.2	0.4	0.7	0.4	5.7

Figure 3: Percent real growth in TOA by service (millions $)[23]

If the DoD can not shift its funding emphasis to allow for advancing spacepower technologies, an alternative may be to ask sister services pay for support they receive from USAF space systems. Former CINCSPACE, General Richard Myers, told reporters at a Defense Writers Group meeting, in January 2000, that, "where appropriate, that makes sense."[24] This would at least relieve the daily budgetary burden the USAF undergoes to pay for space support and free up even more money for advanced R&D.

Additionally, the USAF could directly apply any greater sums of money it receives to advance spacepower capabilities directly to those capabilities vice shifting the money elsewhere. Given the service's daily responsibilities formerly discussed, it becomes "easy" to shift funds from requirements they are originally earmarked for in order to fund immediate operational requirements. Hence, it may be wise to "fence" any money earmarked for advanced spacepower capabilities. This seems advantageous for two reasons. First, it could ensure the money is there to fund such capabilities. Second, it could silence the naysayers who contend the USAF does not want to advance spacepower at the expense of airpower -- who often point to circumstances which seem to illustrate the USAF is much more willing to fund air technology at the expense of space technology.

Lastly, there has always been the argument that spacepower is too expensive for the same service which funds airpower to adequately fund. While various suggestions above would tend to negate this criticism, there also exists the argument that challenges the conventional wisdom that spacepower will always be grossly expensive.

Given serious attempts at utilizing commercial technologies and practices, acquiring technology for efficiency versus "raw performance," as well as employing other mature and "real world" approaches, the cost of advanced space technology can actually come way down. Dr. John Borky, a Chief Engineer at TRW Corporation, spoke of this when he said

> I like to challenge the conventional wisdom about the cost of space systems. We have grown up believing that space somehow is divinely ordained to be obscenely expensive, and we have paradigms for developing space systems that grew up when the threat was paramount and the cost was, if not irrelevant, then at least distinctly secondary. That has now changed. The fact is, that a combination of intelligent use of commercial product services and best practices, technology for affordability as opposed to technology for raw performance and other very real and mature approaches can dramatically lower the cost of space systems. As one example of what is underway to prove that, the Discoverer II program aims to demonstrate a pair of radar satellites at a cost per satellite on orbit of something about 1/10 to 1/5 of what conventional wisdom would say such

> systems would cost….We ought not to just assume things will cost what they've cost in the past.[25]

Conclusion:

The bottom line is that advanced spacepower capabilities -- with all the potential advantages discussed earlier in this paper -- costs money. There seem to be many opportunities, as well as tough decisions to be made, if the nation, the DoD, and the USAF wants a fully capable aerospace force. Money makes the world round -- it also makes things go around the world.

At the national level, there can be increased emphasis placed on partnerships (and associated cost sharing) between commercial, civil, and military space ventures. Many opportunities may exist to realize economies of scale and savings from decreased duplication of effort. This partnering concept seems especially fruitful when considering the military's "support" space missions -- force enhancement and space forces support.

The second major national fiscal issue is the funding of the national organizational changes suggested in Chapter Eight. As the national agencies' space-oriented organize, train, and equip functions pass to the USAF, so too could associated funding.

Third -- and most important and far reaching -- is a national priority to increase overall military-oriented space funding. Fortunately, many of the examples cited herein point to this requirement becoming a reality.

From a DoD and joint perspective, budgetary issues should be worked out to pay for space services rendered. The reality of military space is that one service spends most of the money -- and expends most of the effort -- to support all the other DoD agencies and sister services with space capabilities. Given the enormous investment that space is, this seems untenable if the USAF, or potential Aerospace Force, is also going to have the money to advance its space capabilities.

Two possibilities present themselves to possibly solve this dilemma. First, the budget can be reallocated to reflect the reality of the USAF being tasked with accomplishing the nation's two most technologically advanced, and therefore costly, military capabilities -- air and space (aerospace) exploitation and dominance. Secondly, the sister services and other DoD agencies can be required to pay for services rendered out of their own TOA on a more direct basis.

Within the USAF, or potential Aerospace Force, many opportunities seem to exist for fiscal change to realize more advanced spacepower. First, a central organization -- answering to the CSAF -- could be stood up to conduct non-parochial tradeoff analyses of air and space capabilities to accomplish various aerospace missions. Associated with this, a roadmap could be developed to establish an aerospace mission integration and migration scheme. This type of plan would then lend itself to the USAF being better able to make smart divestiture decisions, in order to more efficiently budget for advancing spacepower capabilities.

Associated with all of these USAF changes is increased force experimentation. This experimentation should be non-parochial and have an eye toward advanced technologies and capabilities. Most important is that doctrine and operational art would follow along.

A penultimate issue is the association of advancing spacepower to the readiness versus modernization debate. It seems vital that the USAF somehow remain ready to accomplish all the daily tasking meted out to it to respond to world hotspots, while simultaneously pursuing advanced capabilities.

Finally, all of these service-specific issues affect the last discussion -- an overall net increase in the USAF's, or Aerospace Force's, budget. All of the factors formerly described contribute to this suggestion -- force structure divestiture, mission absorption, space budget fencing, and reallocation of DoD budget priorities. Associated with this discussion is a line of thinking about decreasing space costs. Given changes in the way of thinking about space technology requirements, i.e. from a "raw performance" to an "efficient suffices" line of thinking, costs can actually come down when mature technologies and tried and true technological approaches are employed.

Money makes the world go round, and it makes things go round the world. Sufficient funding seems the single most critical requirement for advanced national and military spacepower capability.

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[1] As a recent example, Senate Armed Service's Committee Chairman John Warner, in an 8 February 2000 hearing on the FY01 DoD Budget request, said the Defense Authorization Act for FY01 would include defense increases triggered by a $112 billion hike. He foresees not one year of increases, but "five or six" years of increased defense spending (*Defense Alert*, 10 February 2000).

[2] Much of this discussion is gleaned from a presentation the author received from Lt Col Mike Kaufhold, SWC/XR (circa 1994), entitled The Reinvention of Space.

[3] Faber, S. "Global Ambitions," *Discover.* January 1995. p.3.

[4] Unfortunately, the report does not address long term solutions to space range management concerns. The Director of OSTP's Space and Aeronautics office pointed out, "we believe the future of commercial markets and developments is too uncertain to justify selecting which far term alternative to pursue now." (*Inside the Air Force*, 11 February 2000.

[5] For a complete discussion of "dual-use," "spin-off," "spin-on," economic-technology interface see such works as <u>Beyond Spin-Off</u>, published by Harvard Business School, Anna Slomovic's RAND dissertation on "An Analysis of Military and Commercial Microelectronics: Has DoD's R&D Funding had the Desired Effect?" and Victor Utgoff's chapter in St Martin's Press, <u>The American Military in the Twenty-First Century.</u> After a study of such works, the author believes that "dual-use" technologies, i.e. those that can be used by both military and commercial sectors, but funded by DoD, and "spin-off" technologies, i.e. those that are developed by DoD for DoD use, but which have certain civil application, do not hold as much fiscal promise, and do no reflect the reality of today's commercial technologic revolution, as "spin-on" technologies do. "Spin-on" technologies refer to those which are generally developed and funded by commercial concerns, but which can be adapted for military use. Overall, it is the free market competition that will generate both quality products and affordability applicable to both the military and civil sectors. As Slomovic writes, "If the cost of weapon systems are to be contained, the electronics must be produced by firms which have incentives and opportunities to reduce costs. As this study demonstrates, in the majority of cases the DoD is not getting more advanced components for the higher prices it pays." DoD R&D funds must be spent on special military requirements, i.e. those which have no application in the civil market. However, certain criteria such as reliability, temperature tolerance, and radiation tolerance, once thought to be within the military's unique interest, are now being designed in to civil components. The military must take advantage of these increasing capabilities by applying realistic test criteria and requirements.

[6] In their book <u>Beyond Spinoff</u>, the authors note that during the heyday of the spinoff paradigm, i.e. when commercial requirements were being met with defense research and development dollars, "military requirements distorted priorities toward (overly) complex, high performance objectives with limited commercial applicability..." As the spinoff paradigm is left for a more realistic, contemporary, market-place driven, commercial-military interface, the problem should be partially "self correcting," i.e. defense will decline as a fraction of national

technical effort. However, care must be taken by the corporations, so comfortable with the spinoff paradigm of the past, to not adopt civilianized versions of "defense technology paradigms." International competitiveness, as well as national economic and military superiority, would suffer. "American business, accustomed to letting DoD carry much of the burden, has been slow in responding to aggressive technological investments by Japanese firms, even as the latter outdistanced them first in process and then in product engineering. The cost to Americans of carrying around the wrong mental image of how the technological system works will be paid in terms of lost markets, overpriced weapons, and wasted resources."

[7] "Proposed Name Change Has Doubters." Air Force Times, 24 January 2000.

[8] FY00 DoD Authorization Conference Report and FY00 DoD Authorization Bill.

[9] National Press Club Briefing. "Integrating Air and Space: Defining the Orbit." January 12, 1999.

[10] The numbers used herein are taken from the "Department of Defense Budget for Fiscal Years 2000/2001, Procurement Programs," February 1999.

[11] *Air Force Today*

[12] The author developed the "Integrate to Migrate" concept while witnessing and contributing to the air and space integration efforts occurring at Nellis AFB, Nevada during his tour as the USAF Weapons School Space Division Commander. These efforts, led by Maj Gen Glen Moorhead, Air Warfare Center Commander, began as a direct result of efforts on the part of the Space Warfare Center's Aerospace Integration Center (led by Lt Col Warner "Bear" Trest), instructor space weapons officers at the USAF Weapons School Space Division, as well as various members of the Air Warfare Center's staff (most notable among them the Range Management Office).

[13] This seems the "longest pole," but advanced spacepower capabilities, if technologically feasible and operationally significant, can actually be more politically flexible to execute. See Chapter Three for a detailed analysis of this point.

[14] See Chapter Two for a discussion about space force enhancement missions.

[15] "Space Control Horizon." *Washington Times*. 11 Jan 1999. "Air Force to Contribute Funds for Space Control in FY00 and FY05 Budget." *Inside the Air Force*, 8 Jan 1999.

[16] Congress has also showed interest in this area. Sen Warner, in hearings concerning the FY01 DoD budget, remarked about his "particular plans to advocate an aggressive unmanned vehicle program in the authorization bill." As a start, he advocates a goal of having 1/3 of deep strike aircraft be unmanned not later than 2010. This type of thinking and resourcing is a positive step to integrating and migrating missions from air to space.

[17] SecAF Peters was quoted as saying, "Over the period since the Berlin Wall fell, our budget has gone down about 40 percent but our space budget has gone up 3 percent at the same time that TACAIR, lift, housing and everything else has gone down by 40 percent."

[18] Department of Defense Budget for Fiscal Years 2000/2001. "Program Acquisition Costs by Weapon System." February 1999.

[19] Department of Defense Budget for Fiscal Years 2000/2001. "RDT&E Programs (R-1)" February 1999.

[20] Even then, the amount expended seems backward. It makes more sense to be more aggressively pursuing space control technologies at this point for all the reasons previously cited in this paper.

[21] Specifically, the USAF should "play up" any time their funding for advanced space capabilities is notable -- as with their spending of over $60 million per year on the space based laser program.

[22] Professor Donald Goldstein, University of Pittsburgh Ridgway Center's Associate Dean, termed this phrase to describe the recurring trend of giving all services approximately the same TOA. Some claim the numbers are about 33% for each service -- but when taking into account other DoD costs and DoD agencies' TOA, the numbers come out closer to 30% a piece.

[23] National Defense Budget Estimates for FY2000, Office of the Undersecretary of Defense (Comptroller), March 1999.

[24] *Aviation Week and Space Technology*. "Myers: Air Force May Need Other Services' Dollars for Space." Frank Wolfe, January 6, 2000.

[25] National Press Club Briefing. "Integrating Air and Space: Defining the Orbit." January 12, 1999.

CONCLUSION: Why and How?

Chapter Ten

Conclusion: Why and How?

First, America's future security and prosperity depend on our constant supremacy of space; second, while we are ahead of any potential rival in exploiting space, we are not unchallenged, and our future dominance is by no means assured; third, to achieve true dominance we must combine expansive thinking with a sustained and substantial commitment of resources, and vest them in a dedicated, politically powerful, independent advocate for spacepower
-- US Senator Bob Smith, R-NH

Space is a place, not a mission, and we must make tradeoffs where the best investment gives us the best capability to fight and win America's wars.
-- General Michael Ryan, CSAF

The American military is built to dominate all phases and mediums of combat. We don't assume air, land or sea superiority, but instead plan for, execute and seize the initiative.
-- General Richard Myers, Vice Chairman, Joint Chiefs of Staff (former USCINCSPACE)

Space (just as air, land and sea are) is a place -- it is not a mission. Space is not ISR, or communications, or weather, or navigation, or information operations. It is another warfighting medium from which to gain offensive and defensive effects in the battlespace. Given advances in technology such as GPS-guided munitions, spacepower has already proven itself capable of providing militarily significant effects on, in, and through the battlespace. Given the operational and political advantages of more advanced spacepower capabilities, the US can seize the initiative now to plan for more advanced spacepower capabilities, in order to be able to execute all spacepower missions in the future.

Though it is physically very different from any other warfighting medium, space is a part of the aerospace continuum when considering strategic and operational "effects." By virtue of its existence over, around, and above all of the other warfighting media, it maintains the same positional advantages inherent in airpower (speed, reach, coverage, etc) -- but, in many ways, to an even greater degree.

That said, space, as a military operating medium, is not being fully exploited. Though there are positive signs toward contrary trends, it seems the nation may not yet fully recognize why space should be exploited, and there does not yet seem to be a "user" completely organized, trained, and equipped to do so. A cursory look at recent military scientific and technology expenditures demonstrates what some perceive as a lack of foresight by US military planners with regard to exploiting the advantages of space (see Chapter Nine for tables relating current data). In all of today's budgeting, space forces are generally regarded only as merely support for the other warfighting mediums -- though there are seemingly positive trends in some R&D funding proposals.

Interestingly, most government reports, from the 1950s right up to today's USAF Aerospace Integration Plan, documents some of the same advantages of spacepower which are described in Part I of this thesis, i.e. global coverage, high readiness, nonintrusive forward presence, rapid responsiveness, and inherent flexibility. However, very little, if any, mention is made of (and precious little money is authorized for) efforts to fully exploit these advantages by developing a fully functional military space architecture capable of accomplishing not only support missions, but control and application missions, as well.

Granted, there exist various policy issues encouraging this perceived lack of foresight. However, this does not negate the fact that advanced spacepower capabilities are militarily and politically useful -- and that from a realization of these facts, a policy shift seems beneficial. Importantly, if such a policy shift were to occur, the Aerospace Force must be ready to field and operate such advanced systems. The time to prepare for this eventuality is today. As General Estes has said, "we cannot be late to need."

This thesis has attempted, first, to demonstrate the value of military operations from space, i.e. why spacepower is effective and efficient. The reality of employing any form of military power is that the medium's advantages and limitations must be considered. Said another way; it matters not where the "effect" comes from -- as long as the effect is made on the battlespace at the proper moment in the most effective (and preferably efficient) manner.

Therefore, to highlight the advantages and limitations of one military operating medium -- space -- and not withstanding the realities and advantages of joint warfighting, Part I showed the economic and political vulnerabilities inherent in all military force operations are appreciably lower *vis-à-vis* military space operations versus terrestrial military operations. The "why" of advanced spacepower capability is because space forces can potentially "effect" an adversary in ways terrestrial powers find difficult due to spacepower's positional and energy advantages (given various physical limitations of orbital systems).

Due to the lack of a robust and comprehensive spacepower theory (though the seed-corn for same has been laid), there is no a viable spacepower doctrine (which is either driven by or drives a lack of national will). Because of all this, the US' ability to get into, stay, and operate from space is currently not optimized -- though the US is generally considered the world leader in space operations. The nation should improve on what is already good in its space capability, and fix what is broken.

Now is the time to make these improvements. The US is at an historical null period in its geo-history. It faces no monolithic threat requiring tit-for-tat technology development. It can "leap frog" military technological generations allowing it to realize advanced spacepower capabilities more efficiently and effectively. It does not have to fully develop and field successive technological generations of ever-more expensive military hardware. Obviously, this notion is tempered with (but not negated by) the realities of increased commitment of US military resources around the world in lessor threat (to national survival), but greater frequency, contingencies.

Part II, therefore, made many suggestions as to "how" to realize more advanced spacepower capabilities. It began with a discussion of new ways of thinking about space and present, as well as future, changes in perspective, organization, and funding required to make advanced spacepower a reality. Changes seem ripe in how the nation, the Department of Defense and unified commands, as well as the United States Air Force (the potential Aerospace Force) think about, organize for, and budget to attain spacepower capabilities. Using a comprehensive spacepower roadmap, the US can organize, train, and equip itself better to exploit space.

"Better" implies more efficiently and effectively, i.e. faster, cheaper, with streamlined requirements, taking full advantage of military-civil-commercial partnerships. New ways of thinking about military uses of space, as well as the development and operationalization of associated space technologies, will more rapidly realize advanced spacepower capabilities for the US.

Fortunately, recent actions on the part of Congress, as well as the USAF, point to an increased willingness to more seriously fund advanced aerospace power capabilities. Though the USAF has not realized a net fiscal increase in TOA, it is earmarking ever-more funds for advanced science and technology. Hopefully, this trend will continue and accelerate, not only in the fiscal arena, but also in changes in institutional perspectives and organizations to more fully realize advanced spacepower capabilities.

Regardless of good intent, perception is reality. In the end, if national leadership does not perceive such positive shifts (in culture, organization, and budgeting) in the USAF approach to space, their "fix" may very well be to separate the space mission from the USAF into a separate US Space Force. As a 6 March 2000 media report on this issue stated:[1]

> On Capital Hill, and at the White House and the Pentagon, the debate is expanding over whether to carve a separate US Space Force out of the US Air Force's hide…A growing number of the nation's leaders are becoming increasingly concerned that the United States could be left vulnerable in future wars -- offensively and defensively -- if more attention is not paid to space. And some are beginning to believe a separate space force may be the only way to truly protect US security interests…The Air Force, as current stewards of the space mission, "focuses more on airplanes and pilots and bombers and fighters and fixed wing aircraft than on space assets," said Smith who is leading the effort to get the space force issue scrutinized by Congress…Smith said the Air Force leadership is committed to doing the right thing but needs to think differently about space…Many senior Air Force officials have fired back that the service fully values the space mission, although there is internal debate over how aggressive the Air Force should be about space…A 13-member congressional panel is being named to look at all aspects of how a space force would operate…Called the "Commission to Assess US National Security Space Management and Organization," the panel also will look at whether a space corps, similar to the Marines' relationship with the Navy, might be a good alternative…It will examine other space areas, including how classified and nonclassified space programs should be handled and if an assistant secretary of defense for space position should be setup at the Pentagon…If a separate space force were to be created, most of the personnel and hardware would come from the Air Force…"Space is not just an asset of the Air Force," Smith said. He said the Air Force currently is in the same position that the US Army was in the late 1940s, when the Army lost its air component. "The Air Force leaders have to think of the future," he said…Within the Air Force itself, the service is undergoing its own bloodletting on the subject, with differing views on how best to protect the (space) mission.

Regardless of external and internal institutional debates, the nation may very well come to grips with why spacepower is important. Once this occurs, the nation, DoD and unified commands, as well as the USAF (the potential Aerospace Force) would be called upon to make appropriate changes in perspective, organization, and budgeting to effectively make it a reality. The product of these sometimes institution-jarring changes could be a national ability to rapidly and effectively defend global national interests at decreased costs in national treasure, natural resources, political capital -- and most importantly, lives.

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[1] *Florida Today*, 6 March 2000.

Appendix One

Enabling Technology -- The Military Spaceplane

The Space Operations Vehicle will be our country's first Space Superiority weapon system, capable of gaining and maintaining control of the space medium and providing freedom to conduct space operations without interference from an adversary.
-- AFSPC Space Operations Vehicle CONOPS, 6 February 1998

As discussed in the body of this thesis, there exist many technologies that will enable a more advanced military space capability. Most important among them are the myriad of technologies that sum to the military spaceplane (MSP) -- an advanced technology which will allow for the following missions:

- Counterspace operations
- Real-time protection of domestic and friendly force on-orbit assets
- Rapid, recoverable ISR
- Satellite deployment, redeployment, recovery, upgrade, refueling and repair
- Space-based deterrence in areas unreachable by land, sea, and air forces
- Space-based resource integration into conventional force packages
- Worldwide weapons delivery within minutes of launch

As Air Force Space Command's spaceplane CONOPS says:

> This revolutionary weapon system, designed for high sortie rate operations and assured affordable access to space, will provide global and orbital payload delivery within hours of notification and within minutes of launch. Combined with existing air, ground and naval forces, the (military spaceplane) becomes a force multiplier and strengthens national defense strategy through omnipresence into areas unattainable by other forces (or more efficiently or effectively attained by space forces). With the (military spaceplane's) ability to rapidly establish virtual presence, and with capabilities that span several operational areas while employing inherent speed, range, flexibility and precision, the "Joint Vision 2010" goal of Full Spectrum Dominance becomes more achievable.[1]

The complete military spaceplane system is made up of four basic subsystems -- the space operations vehicle, the space maneuvering vehicle, the common aerospace vehicle, and the modular insertion stage. The bulk of the information in this appendix is culled directly from the Air Force Research Lab's "Space Operations Vehicle System Technology Roadmap (version 4.5)," published by the Space Operations Vehicle System Program Office on 24 November 1998. AFRL is currently working on an updated version of this roadmap, reflecting significant changes in NASA/USAF partnerships.

This appendix covers the following general areas: an introduction, an explanation of the acquisition approach, a discussion of operational and key objectives, then explanations of the four main subsystems, and finally acronym explanations. A complete discussion of technology implications and a comparison of this technology to NASA's reusable launch vehicle technology can be found in the basic AFRL document.

1.0 Introduction:

This Technology Roadmap provides a the plan for development of military unique technologies necessary for the development, manufacture and use of a highly-operable, affordable and capable Space Operations Vehicle (SOV) System. It is founded and driven by the SOV Acquisition Plan (which is summarized in Section 2), and the SOV CONOPS developed at Air Force Space Command.

The development of this technology roadmap began in late 1996, and the document has evolved responsively to program evolution since that time. The justification for the technology program, particularly the need for an Air Force (AF) funded technology development effort, is provided in a separate document. This document simply defines the results of the technology planning process for SOV.

1.1 Roadmap Process:

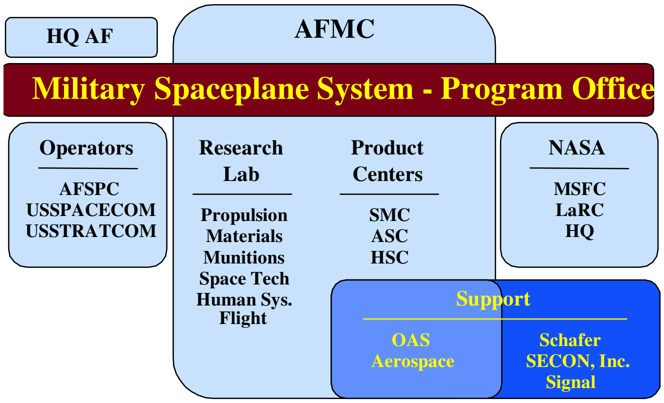

Figure 1.1 SOV Program Participants

The SOV Roadmap was prepared by the Air Force Research Laboratory (AFRL) SOV System Program Office. The program will be executed by a Technology Development Team led by the AFRL. It will involve participation from a variety of organizations, including NASA, AF Space and Missile Systems Center (SMC), AF Aeronautical Systems Center (ASC), AF Human Systems Center (HSC) and several directorates of the AFRL.

The Roadmap Team applied a simple process to develop the Technology Roadmap. Figure 1.2 shows the systematic logic used by the Roadmap Team.

Figure 1.2 shows the overall process used for planning the SOV development program. The Roadmap Team was responsible for determining what technology projects are needed to enable a future system to meet the operational requirements anticipated.

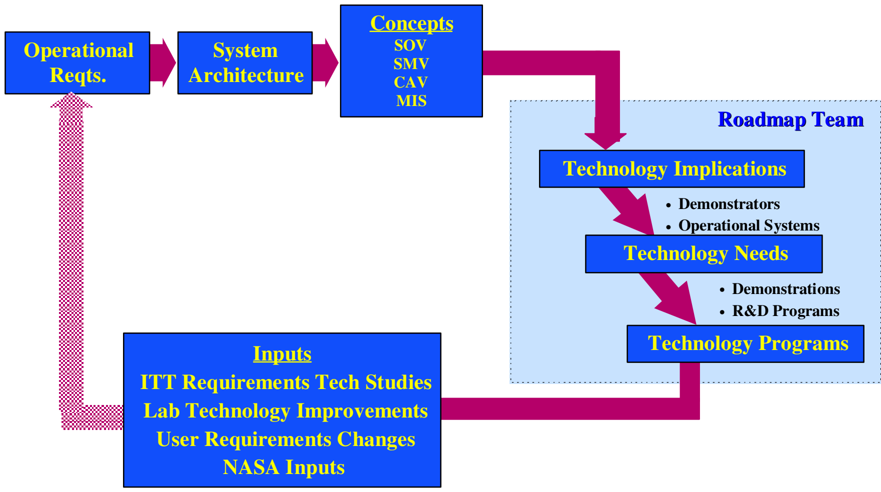

Figure 1.2 Technology Roadmap Development Process

It begins with mission and operational requirements and moves through definition of system concepts and the technology implications of the requirements on system concepts. These implications were defined in detail (including consideration for NASA programs and technology capability), and the Roadmap Team derived a set of detailed technology objectives and then technology programs to meet those objectives.

1.2 SCOPE and organization of document

This appendix is an excerpt of AFRL's document intended to establish top-level technology development plans for the SOV. It also details specific technology goals to meet the performance and functional requirements in the areas of mission, design, reliability, safety, operability, and support. This document will:

a) Provide a starting point for the evolutionary development of the SOV technology goals and define appropriate science and technology (S&T) programs.

b) Define key technology areas, objectives and goals to be addressed in S&T programs.

c) Quantify, to the extent possible, the impact of key technologies on SOV performance, reliability, operability (turnaround) and affordability.

The report is organized to allow the reader to understand the results quickly without getting bogged down in details. However, the details that were derived throughout the planning process are provided as appendices in this document.

1.3 Definitions

Space Operations Vehicle System. A Space Operations Vehicle (SOV) is a military weapon system consisting of several parts, including one or more flight vehicles, crew, support facilities and a weapon / payload package. It is capable of operating in and through the space environment. It is launched from the earth to the space environment, performs in-space military operations, returns to the earth and is then reused for another mission. SOVs differ from current expendable launch vehicles (ELVs) because they address multiple mission areas, where ELVs primarily address Space Forces Support. SOVs can perform direct warfighting missions (Force Application, Space Control, and Force Enhancement), as well as provide a Space Forces Support capability. An SOV is analogous to a multi-mission fighter aircraft, capable of executing a variety of missions.

The AFRL SOV System Program will include four key parts: (1)SOV flight vehicle and support systems, (2) Space Maneuver Vehicle (SMV), (3) Common Aerospace Vehicle (CAV), and (4) Modular Insertion Stage (MIS). The SMV is a reusable upper stage and spacecraft that allow for short-term or temporary space operations from a rapidly deployed platform. The CAV is a maneuverable entry vehicle capable of carrying a variety of payload types for deliver to global sites. The MIS is a low-cost expendable upper stage for orbital payload insertion from suborbital flight conditions.

Military Aircraft-Like Operations. The SOV is envisioned to be capable of operating like a military aircraft. This means that it will reflect key attributes such as rapid vehicle turn time, high system availability, ease of maintenance, field reparability, flight testability etc. These operability issues are the primary drivers for military systems. Military aircraft have demonstrated these characteristics for many years, but space systems have not consistently done so. For this reason, the SOV Program will treat “operations” as a technology. In fact, “operations” is a form of process technology. For the SOV, the operations are the compilation of the activities performed to deliver the SOV vehicle to its destination.

This characterization (of operations as a technology) is not typical in the aerospace and defense industry. It is a must in this situation. However, the understanding of operations processes in the space transportation industry (whether military or not) is fairly immature with respect to other transportation industries, like overnight package delivery. In the latter, the processes used to ensure maximum efficiency and safety of crews, supply flows, etc. has been studied and optimized as a technology. The SOV Program must do the same to achieve a clear understanding of how the more traditional “technologies” must be progressed to meet future requirements.

“Operations” must be treated like a technology field, an area to be researched and matured. To mature operations technology, vehicle systems level demonstrations must be performed. For instance, to demonstrate rapid system turn times, a flight demonstrator would be required to capture all of the operations in turning a vehicle. While the vehicle subsystems will be designed with turn time taken into account, the integrated system must be defined to determine what those operations are and with in what order they must be performed.

2.0 Acquisition Approach

This section summarizes the overall SOV Acquisition Plan. It is intended to simply lay the framework for the technology program and to explain the goals of the four-phase approach.

Later, the technology program plan discussed throughout this document will refer to the phases outlined here.

The SOV System Acquisition will occur in four distinct phases: (1) Technology Leveraging, (2) Technology and Flight Demonstrations, (3) Residual Operational Capability Demonstrations, and (4) Full Operational Capability. Each of these four phases applies equally to the systems making up the overall SOV system: the SOV, SMV, MIS and CAV.

Acquisition will be executed through a partnership between the Air Force and NASA. NASA's primary responsibility will be to develop the SOV demonstrator vehicle through its Future-X program (see Figure 2.1). The Air Force's responsibilities fall in two areas: (1) defining requirements for all facets of the SOV System (including the SOV demonstrator) and (2) developing and demonstrating the SOV payload systems (SMV, MIS, and CAV) and support infrastructure. The Air Force also has the responsibility of ensuring that the Future-X demonstrator design meets the prescribed military requirements.

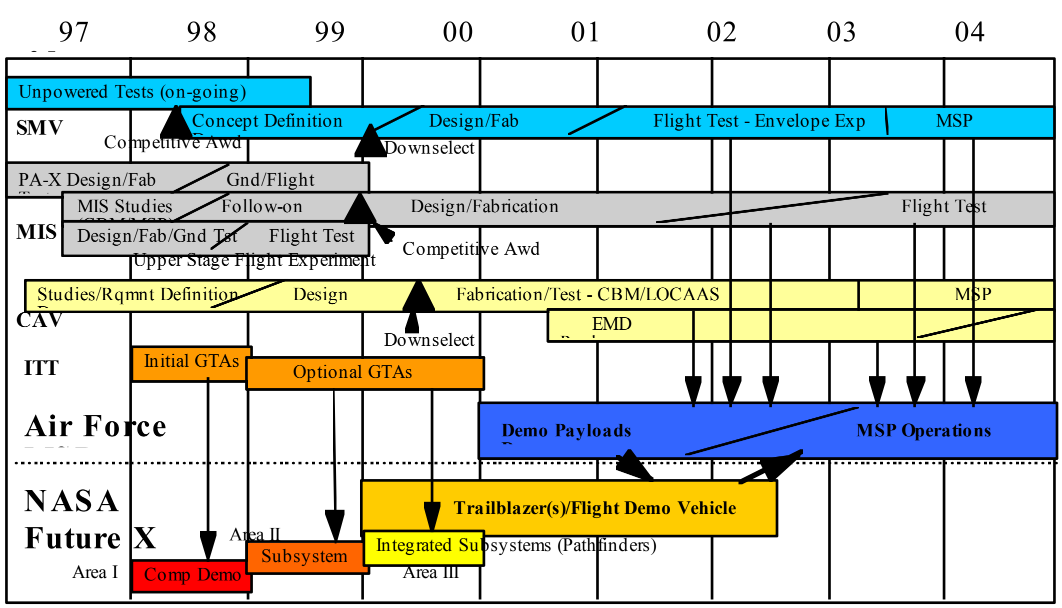

Figure 2.1. Four-Phase Acquisition Plan

2.1 Acquisition Schedule

To minimize overall program risk, the plan includes "go-no-go" decision points between Phases II and III and Phases III and IV prior to commitment of major production resources. Three technology roadmap points are identified where required technologies must be developed, to a point where they have been tested in a simulated operational (relevant) environment, before proceeding to the next program phase. These points occur between each major phase.

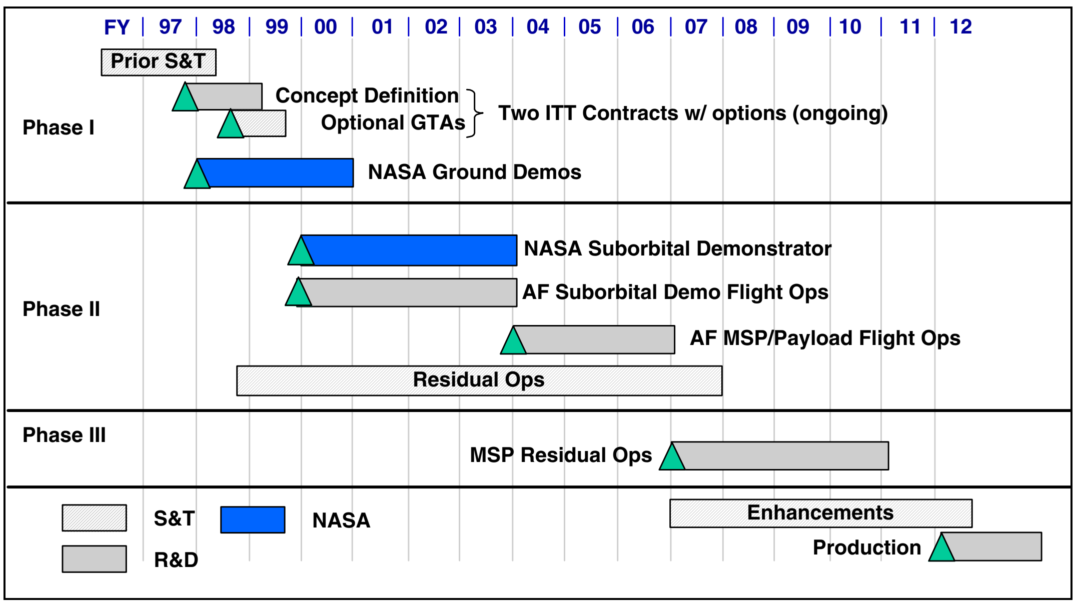

Figure 2.2. Four-Phase Acquisition Schedule

2.2 Technology Leveraging: Phase I

During Phase I, key enabling technologies will continue to be developed and demonstrated, but the SOV Program Office will coordinate closely with AFSPC to continue Operational Requirements Analysis to further refine and develop the SOV Requirements Matrix found in the SOV SRD. The Program Office will also continue supporting AFSPC in defining system missions, trading requirements with capabilities, updating requirements, programmatic documentation and presentation material.

Phase I also includes demonstrations of technologies related to development of the payload systems (SMV, MIS, CAV) beyond the military unique technologies needed to develop a suborbital SOV demonstrator. The Program Office has awarded two 18-month Integrated Technology Testbed (ITT) contracts to begin this process with limited technology demonstrations. Technology work accomplished under these contracts will be coordinated with NASA for inclusion in its Future-X Program development of the suborbital SOV demonstrator. The ITT effort also includes developing initial designs of a suborbital SOV flight vehicle system that is traceable to both the NASA-developed follow-on flight demonstrator and a fully-orbital SOV flight vehicle system.

In parallel with the ITT contracts, the Program Office also has several contracts to begin technology development and system designs for the SMV, MIS and CAV payload systems. The SMV effort entails a full-scale composite wing box ground test and 90%-scale low-speed autonomous approach and landing drop tests. The MIS will undergo low-cost engine development and testing. CAV applications and integration studies will be performed.

In conjunction with the ITT and payload system technology efforts, the Program Office also supports the AFRL Integrated Powerhead Demonstration (IPD) propulsion technology development program. This project is developing propulsion technologies that are critical to meeting the reusability and operability needs of future rocket engines for suborbital and orbital operational SOVs.

2.3 Technology and Flight Demonstration: Phase II

Phase II will continue technology development and demonstrations by completing the optional ground technology demonstrations proposed in the ITT contract awards. The results of these efforts will also be provided to NASA for inclusion in the SOV suborbital demonstrator effort.

The primary focus of Phase II, however, is to flight demonstrate the key enabling technologies for the SOV system. Competitive contract(s) to develop an SOV technology flight demonstrator vehicle will be awarded through the NASA Future-X Program. These contracts will execute the design, development and flight test of a fully-reusable, suborbital SOV technology demonstrator (different vehicle than the X-33 vehicle) capable of delivering 12,000 pounds of payload to LEO. All systems and subsystems, including payload and payload delivery systems, and operations will be traceable to an orbital SOV flight vehicle system.

SOV payload systems and the required technologies will be readied for flight testing, on surrogate systems and/or the suborbital SOV demonstrator if available. The following development and flight test activities will be accomplished through competitive contract awards. SMV flight testing will be expanded to include powered flight tests from aircraft or expendable launch platforms to better examine the SMV in its operational environment and expand its flight envelop. MIS engine development tests will continue and will include integration with appropriate payloads and the SOV system. A CAV flight test demonstrator will also be developed and ready for integration with an SOV flight vehicle.

During Phase II, the propulsion technology work started under the IPD project will transition into a prototype engine development program, the XLR-X. This DCLR effort will lead to engine components and subsystems that can be demonstrated on the suborbital SOV demonstrator. The ultimate goal of the XLR-X project will be to develop a complete reusable and operable propulsion system for the operational orbital SOV.

Phase II will conclude with the integration of SOV payload systems with a suborbital SOV demonstrator. Incremental flight envelope expansion will be executed for both the separate SOV demonstrator and the integrated SOV flight vehicle.

2.4 Residual Operational Capability: Phase III

Phase III transitions the suborbital SOV demonstrator into a residual operational capability with the integrated SOV and payload systems. During Phase III, continuing suborbital SOV demonstrator flight tests will focus on military operations and applications. In addition to expanding the flight envelope further, the flight test program will also test and demonstrate payload system integration and deployment for militarily useful missions in space. The military operational requirement of rapid system turnaround (within eight hours - landing to take off) will also be extensively tested, and the of two hours will be demonstrated.

With an integrated SOV system in flight test, the payload systems will also be extensively tested in an operational environment. As part of the envelope expansion program an SMV will be externally mounted on the suborbital demonstrator, flown mated, and placed into LEO from the pop-up maneuver of the SOV. Continued flight testing of the MIS will include integration with the SOV demonstrator and/or SMV with the eventual deployment of a payload on the MIS into a "working orbit". Continued flight testing of the CAV will include external mating and launch from the SOV demonstrator.

The XLR-X engine development will continue with prototype engine systems integration and ground testing. Additional S&T investments will occur to develop technologies that will eventually be inserted into an orbital SOV system.

Conclusion of the Phase III effort will result in the second "go-no-go" decision point: a low rate initial production (LRIP) of the SOV demonstrator modified to conduct residual military operations.

2.5 Full Operational Capability: Phase IV

This final phase of the SOV development will build upon the successful completion of the previous three phases and will result in a competitive contract award to design, develop and build an orbit-capable SOV system incorporating all of the components previously described. It will include the integration of the engine produced by the XLR-X effort, full payload systems (SMV, MIS, CAV) integration and demonstrations in an operational environment, and demonstration of a high operational tempo (rapid turn around) and low cost military access to space.

The payload systems will also undergo complete system integration and operational testing as part of the complete SOV System. The SMV will be integrated with the orbital SOV. Flight testing of the SOV-SMV system will include multiple pop-ups and single orbital deployments demonstrating full operational capability meeting the user's requirements. The CAV will be integrated and flight-tested with both the SOV and SMV. Tests will be conducted from both suborbital and orbital releases and the CAV operational capability to support negation of hard and deeply buried targets will be demonstrated during this Phase. The MIS will be integrated with the orbital SOV and will demonstrate on-orbit payload deployment.

This development and flight testing effort will lead to a full rate operational SOV system production decision.

3.0 Operational and Technology Key Objectives

Table 3.1 Technology Readiness Level Definitions

TRL 1	**Basic principles observed and reported**
TRL 2	**Technology concept / application is formulated**
TRL 3	**Analytical and experimental evidence for critical functions, and/or characteristic proof of concept available**
TRL 4	**Component and/or breadboard assembly demonstrated in laboratory**
TRL 5	**Component and/or breadboard assembly demonstrated in relevant environment**
TRL 6	**System validation model demonstrated in a simulated environment**
TRL 7	**System validation model demonstrated in space**
TRL 8	**Actual system completed and flight qualified through test and demonstration round or flight)**
TRL 9	**Actual system flight proven through successive operations**

Evaluations of technology readiness to meet AF requirements will reflect different technology readiness levels (TRLs) than an evaluation based on NASA or commercial requirements. NASA's programs will advance the technology necessary for a reusable launch vehicle (RLV) capable of replacing the Space Shuttle (NASA's fundamental goal). For the same technology, NASA and the AF will have different TRLs.

The SOV system requirements drive two basic system design goals: (1) Military Aircraft-Like Operations and (2) Vehicle Integration within Mass Fraction. These goals consist of technology areas as shown in Figure 3.1.

Figure 3.1 SOV Technology Goals / Areas

Note that the technology areas shown (and described in detail in Appendix A) are not limited to "traditional" airframe/propulsion technology areas. Those under "Military Aircraft-Like Operations" are called Operations Technology Areas. Those under "Vehicle Integration Within Mass Fraction" are called Vehicle Technology Areas. This breakout allows for a systematic development of program objectives aligned with the areas presented.

Recall that the development of the set of technology projects to enable SOV followed a three-step approach.

4.0 Space Operations Vehicle flight vehicle and support systems

Once the SOV technology planning team developed and understood the technology implications of the mission and vehicle requirements for the SOV flight vehicle system, it developed a set of technology objectives for each technology area. These objectives, which are presented completely in Appendix C, define the framework for the Phase I - Phase IV technology programs for the SOV System.

As derived from the list of technology objectives, and extensive discussions of the planning team, the top technology issues for the SOV flight vehicle and the demonstrator vehicle are provided in Table 4.1.

Table 4.1 Top SOV and SOV Demonstrator Technology Issues

OPERATIONAL SOV	DEMONSTRATOR SOV
Durable, Repairable High-T TPS	Durable, Repairable High-T TPS
Integrated Health Monitoring	Integrated Health Monitoring
Lightweight Composite Materials	Lightweight Composite Materials
Field-Repairable Structure, Tanks	Field-Repairable Structure, Tanks
Field-Reparable Propulsion	Field-Reparable Propulsion
Durable Tanks and Structure	Durable Tanks and Structure
All-weather TPS	Safe Parallel Ground Processing with Cryogenics
Highly-Reliable Reusable Rocket Engine	
Safe Parallel Ground Processing with Cryogenics	

The enabling technologies (those necessary for a baseline SOV) must be captured in S&T programs. These S&T programs must demonstrate the key enabling objectives in both operations and technologies. The enabling technologies identified above must be made available in time for the SOV Flight Vehicle system development. To allow for development of a flight vehicle that can meet the SRD requirements, significant technology development and demonstration of operations must be accomplished. Section 2 outlined the AF Acquisition Strategy for the SOV System, and this strategy called for a systematic program for maturing and demonstrating operations and vehicle technologies. This section now defines the actual programs recommended to meet this need for the SOV Flight Vehicle Systems. Sections 5-7 address the same for Space Maneuver Vehicle , Common Aerospace Vehicle and Modular Insertion Stage, respectively.

The Air Force Research Laboratory (AFRL) is presently developing technologies in a variety of areas that will result in an increase in the technology readiness of SOV important technology. AFRL organizations have also identified a variety of new-start technology programs that can further address key technology issues related to the SOV System.

4.1 Phase I Technology Programs

The primary technology program in Phase I is the ongoing Integrated Technology Testbed (ITT). The ITT is the first acquisition for the SOV System Program. It is intended to perform concept definition for future SOV flight vehicle concepts, and to reduce risk for progression of the overall program to the next acquisition phase.

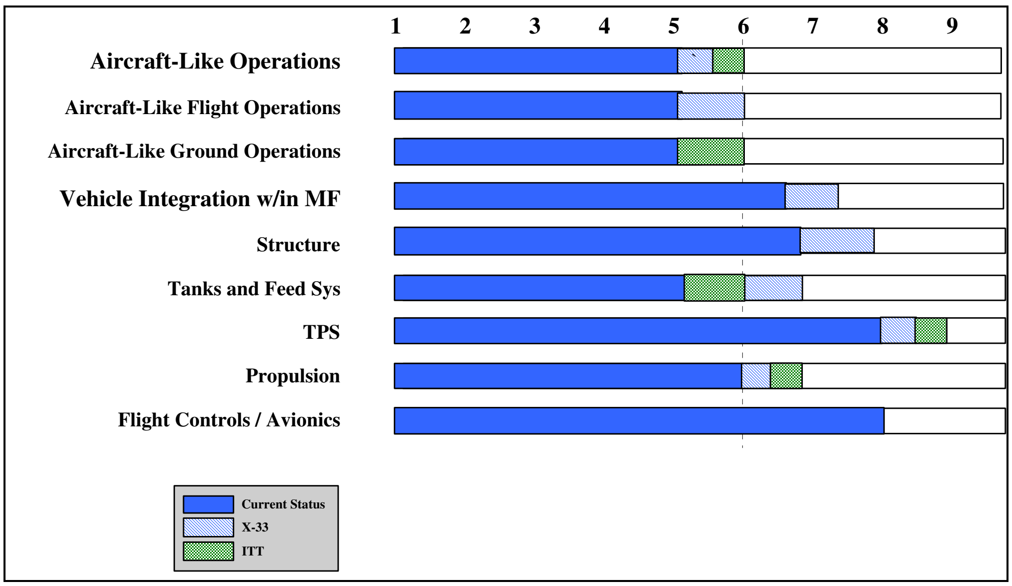

Figure 4.1. Technology Gaps in Readiness for Phase II

4.2 Phase II Technology Programs

Recall that the primary focus of Phase II is to flight-demonstrate the key enabling technologies for the SOV flight system. NASA will develop the flight demonstrator vehicle, and the Air Force, under S&T funding, will develop several key technologies through execution of laboratory programs. The need for these Phase II programs is illustrated in Figure 4.2 below. Notice the technology gaps, or TRL levels that are too low to continue into Phase III of the program. To fill these gaps, the AFRL has defined the technology programs described in this section.

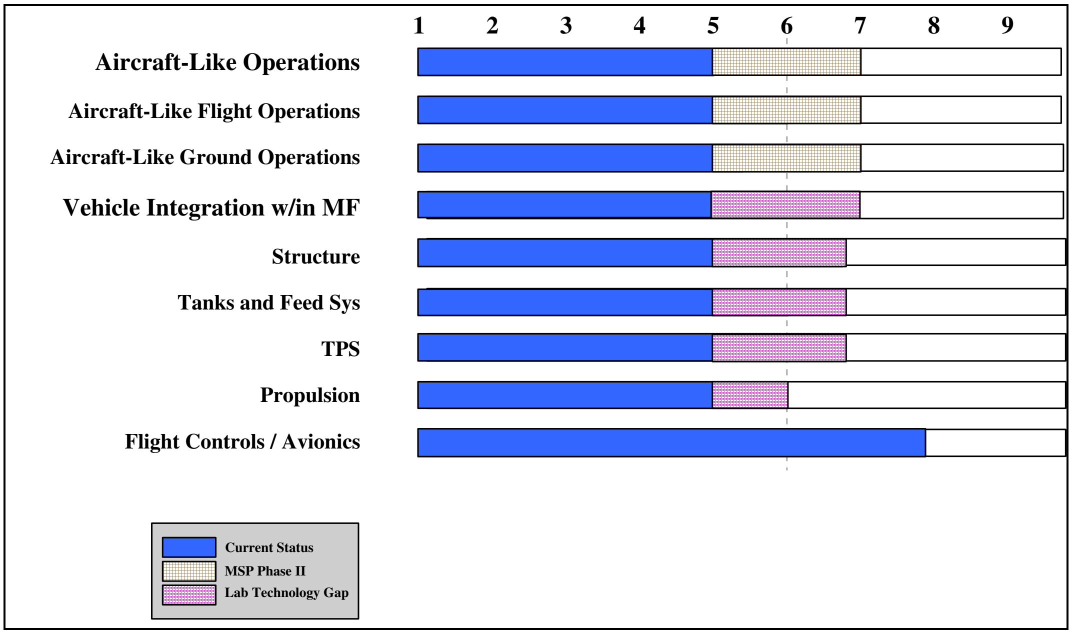

Figure 4.2. Gaps in Technology Readiness for Phase III

The following sections describe the Phase II technology projects planned for addressing the SOV flight system technology objectives. These projects are completely consistent with the S&T POM planned projects that are tracked in the AFRL Requirements Correlation Database. The project numbers in the following tables identify each project and allow for correlation to technology and mission needs. Full project descriptions are provided in Appendix D of this document.

4.2.1 Structures and Materials

The focus of Phase II projects in Structures and Materials is primarily on decreasing structural weight of various vehicle components. Weight will be a determining factor in whether vehicles can be built affordably and whether useful military payloads can be delivered to either orbit or appropriate suborbital flight conditions by the launching vehicle. Table 4.2 lists the technology projects for Phase II. Recall that full descriptions are provided in Appendix D.

Table 4.2 Phase II Technology Projects for SOV Airframe / Structures

#	PROJECT	ORG.
	Airframe / Structures	
571	Affordable Composite Launch Vehicle Structures	AFRL/VS
660	Advanced Composite Payload Shroud Flight Experiment	AFRL/VS
670/671	Lightweight, Durable Launch Vehicle Structures/Flight Experiment	AFRL/VS
	Metal matrix Composites for Structures	AFRL/ML
	Advanced Configuration Concepts (Mig. To Space)	AFRL/VA
	Integrated Structures/Tanks/TPS Concepts (Mig. To Space)	AFRL/VA
	Repair of SOV Structures/Tanks/TPS (Mig. To Space)	AFRL/VA
	Affordable Composites (Mig. To Space)	AFRL/VA
	Structural Dynamics (Mig. To Space)	AFRL/VA

4.2.2 Tankage and Feed Systems

Although this technology area includes all aspects of propellant deliver systems, the Phase II focus for technology work is on the actual cryogenic tanks. The issue is minimization of mass, and two technology projects, listed in Table 4.3 below, will be conducted to demonstrate that lightweight cryotanks which can meet operability goals for SOV can be manufactured.

Table 4.3 Phase II Technology Projects for Tankage and Feed Systems

#	PROJECT	ORG.
	Tankage and Feed Systems	
569	Cryogenic Propellant Tank	AFRL/VS
667	Cryogenic Propellant Tank Flight Experiment	AFRL/VS
	Non-Autoclave Materials and Resin Systems Eval and Dev	AFRL/ML
	Non-Autoclave Material Systems and Processes (Initiative)	AFRL/ML
	NDE of Non-Autoclave Processes	AVRL/ML

4.2.3 Thermal Protection Systems

This area is one of the most critical to allowing SOV systems to meet operations goals (availability and sortie rates). Near-term programs, particularly those in Phase II, are critical to ensuring the credibility of future SOV development efforts. New materials must be defined and demonstrated in relevant environments. Design approaches for attachment of TPS components must also be considered and demonstrated. Table 4.4 lists the TPS Phase II technology projects the Air Force plans to execute.

Table 4.4 Phase II Technology Projects for SOV TPSs

#	PROJECT	ORG.
	Thermal Protection Systems	
773	Reusable Load-Bearing Thermal Aeroshell	AFRL/VS
774	Reusable Load-Bearing Thermal Aeroshell Flight Experiment	AFRL/VS
	Advanced Energy Management for CAV/SMV/SOV (Mig to Space)	AFRL/VA
	Actively-Cooled Structures for Adv. Spaceplanes (Mig to Space)	AFRL/VA
	Materials Assessment/Definition for SOV TPS	AFRL/ML
992	Hypersonic Nosetip and Leading Edge Materials	AFRL/ML
	Durable Hypersonic Coating Systems	AFRL/ML
	M&P for Integrated TPS (initiative)	AFRL/ML
	M&P for Adv. Thermal Mgt. Systems (initiative)	AFRL/ML
	M&P for Rapid Repair Technology (initiative)	AFRL/ML
	M&P for Hot Structures (initiative)	AFRL/ML

4.2.4 Propulsion

The primary activity in the Propulsion Technology Area for Phase II is the Integrated Powerhead Demonstration (IPD)effort, which is supported by several technology projects (as identified in Table 4.2. The IPD intends to demonstrate highly operable cryogenic propulsion system components, namely turbopumps and bearings.

Table 4.5 Phase II Technology Projects for SOV Propulsion

#	PROJECT	ORG.
	Propulsion	
351	Operable SOV Engine Demonstration (Mig. To Space/Initiative)	**AFRL/PR**
937	Open Woven CMC Structure	**AFRL/ML**
	Adv. Nickel Alloq for Oxygen Rich Environment	**AFRL/ML**
925	Advanced Metallics for Rocket Engines	**AFRL/ML**
	Low Cost C/SIC by Melt Infiltration	**AFRL/ML**
	M&P for Actively Cooled Structures (initiative)	**AFRL/ML**

The focus of the IPD is actual development of a 250 Klbf thrust class engine. This engine is designed to offer gigantically increased operability over current rocket engines. Current estimates indicate an eventual production derivative of IPD could save 97% of the Space Shuttle Main Engine (SSME) life-cycle costs. The IPD LOX/LH_2 engine technology program will transition to a full engine demonstrator program in FY 2000. Goals for the demonstration program will be assembly of technologies demonstrated during IPD along with testing and development to meet the operability and longevity requirements of the SOV SRD.

One other activity in Phase II for Propulsion is the SOV Propulsion for Residual Operational Capability. This effort will provide an near-term reusable propulsion system capability to allow for early suborbital SOV vehicles to operate in the AF following the test program.

4.2.5 Flight Controls / Avionics

The Phase II Flight Controls / Avionics technology projects vary widely in focus and technology objective. Several programs will be performed by the AF, and they are listed in Table 4.6.

Table 4.6 Phase II Technology Projects for Flight Controls / Avionics

#	PROJECT	ORG.
	Flight Controls / Avionics	
	Control Laws for MSP FQ (Mig. to Space)	**AFRL/VA**
	VMS Technologies (Mig. to Space)	**AFRL/VA**
	Adv. Actuation Technology for Space Vehicles (Mig. to Space)	**AFRL/VA**
	Combat Automation Requirements Testbed	**AFRL/HE**
1129	Spaceplane Avionics Initiative (Mig. to Space)	**AFRL/SN**
1148	Conceptual Info. Architecture for Assured Space Access (initiative)	**AFRL/IF**
	Man-Machine Interface and Imbedded Training for Space (Mig. To Space)	**AFRL/HE**
	Low Cost Structural GPS and SAR Antenna Windows	**AFRL/ML**
	High Temperature Sensors for Avionics	**AFRL/ML**
995	Reusable Structural Antenna Window Composite	**AFRL/ML**
994	Infrared Windows for High Mach Capability	**AFRL/ML**

These programs will address key operational issues related to the use of state-of-the-art systems on an SOV vehicle which occur as a result of the more harsh flight environment that these systems will be exposed to during operation. Phase II will also pay close attention to the technologies needed to allow for real-time monitoring of vehicle health status (for several different subsystems) and non-destructive techniques for inspection and evaluation of vehicle operability. These efforts are critical to ensuring rapid turnaround of future operational systems.

4.3 Phase III SOV Technology Programs

Recall that the primary focus of Phase III is to execute extensive flight testing of the suborbital SOV vehicle and payload systems. The propulsion system for the full SOV flight system to be built in Phase IV will also continue significant development. Phase III also provides an opportunity to execute technology efforts in areas that are considered enabling for the full-up SOV flight vehicle, but were not addressed in Phase II. The need for these Phase III programs is illustrated in the below. Notice the technology gaps, or TRL levels that are too low to continue into Phase IV of the program.

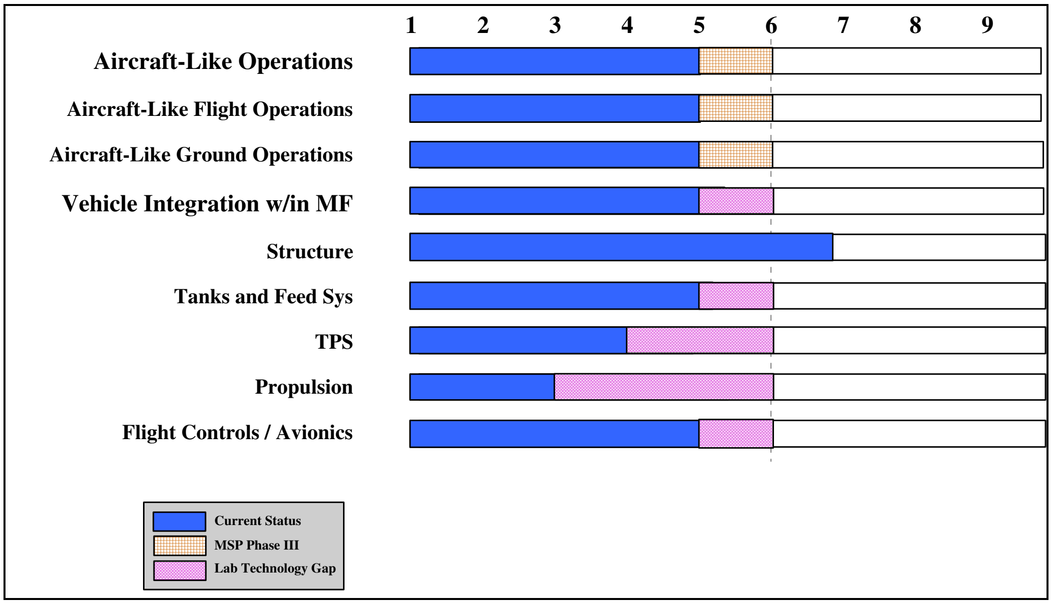

Figure 4.3. Technology Gaps for Phase IV Readiness

Table 4.8 identifies six technology initiatives for Phase III. These programs are essentially technology focus areas important to continuing the program into Phase IV. Because the timeframe is beyond the current AF POM cycle, defining specific projects is difficult at this time.

Table 4.8 Phase III Technology Programs for SOV Flight Vehicle Systems

PROGRAM
Structures Initiative
Tankage Initiative
TPS Initiative
Propulsion Initiative
Avionics / Flight Controls Initiative III

So the focus areas provide a framework for future planning, while allowing for simple budgeting exercises and discussions regarding what projects are required. What will be performed in these focus areas will be based on the technology objectives that must be addressed by the end of Phase III. Recall that these are provided in Appendix C. The following paragraphs attempt to describe the key areas of focus with each program.

4.3.1 Structures Initiative

The Structures Initiative is focused on several key technology objectives. Different structural materials will be examined for utility in SOV flight vehicle design, including titanium matrix composites, ceramic matrix composites, graphitic foams and advanced carbon-carbon coatings. High -temperature seals and non-flammable hydraulics will also be developed. Issues such as rapid reparability of structural components will be addressed through the work in this initiative.

4.3.2 Tankage Initiative

Tankage issues addressed by Phase III projects generally fall into two categories: (1) reduction of gross vehicle weight or associated margins and (2) affordability. Projects in areas like highly accurate liquid hydrogen gauges, unlined hydrogen tanks, lightweight metallic tanks, improved seals for cryogenic tanks and low-cost fabrication techniques for hybrid structures.

4.3.3 TPS Initiative

Phase III TPS efforts will examine all aspects of TPSs, including component technologies as well as overall design for reliability and durability. Ceramic matrix composites will be developed for standoff TPS applications. Load-bearing TPS will be developed to allow for more integrated airframe / TPS approaches. Concern for actual orbiting vehicle safety as well as ground-operations durability will be addressed through efforts to develop TPS approaches that can endure debris impacts.

4.3.4 Propulsion Initiative

The focus of Phase III propulsion activities is the XLR-X engine development, which is a natural follow-on to the IPD program. The XLR-X is focused on providing flight-capable hardware for flight demonstration in Phase III of the SOV Acquisition Strategy. Technology projects will focus on continuing to develop additional operable component technology for high-performance cryogenic rocket engines. Specific foci include actively cooled nozzle and combustor panels, advanced coatings and lubrication materials, and new methods for handling cryogenic propellants to meet SOV ground operations requirements.

4.3.5 Avionics / Flight Controls Initiative II

Phase III Flight Controls / Avionics projects will focus on developing highly-reliable technologies capable of high-temperature operation while performing traditional and non-traditional space-type functions. The initiative will develop techniques and materials for allowing IR mission sensors in a high-temperature environment, including IR window materials and high-performance IR sensors. High-temperature electronics will be developed to allow for robust, highly reliable operation while maintaining low mass for current functionality.

4.3.6..Phase III Funding

The funding required for Phase III projects has not yet been defined. The specific projects must still be defined with more detail before realistic funding requirements can be developed.

4.4 Phase IV Technology Programs

The focus of Phase IV S&T technology work is enhancement of the production-line vehicle performance, cost or operational flexibility. A variety of technologies can provide enhancement, and the work in those technology areas will all be grouped under one technology program entitled "Orbital SOV Enhancements." The program is aimed at long-term SOV improvement and will be executed through a variety of smaller contracts run by AFRL directorates.

As an example, durable TPS will be improved to allow for 200 sorties of operation. Durable structures technology will be worked to allow for 500 sorties of operation. Reusable engine technology will allow for 200 sorties of operation.

5.0 Space Maneuver Vehicle

The SMV is an integral component of the SOV reusable system architecture. The SMV is a small, powered space vehicle that functions as a reusable satellite with a variety of available payloads. SMV can potentially perform the following missions:

Tactical Reconnaissance from Space

Gap Filler in Satellite Constellations

Rapid Deployment of Sensor or Communications Constellations

Space Object Identification and Surveillance

Space Asset Escort

SMV is an orbital component of the SOV system. It can operate in orbit longer than SOVs nominal 24-72 hour on-orbit duration. The SMVs small size and ability to change both orbital inclination and altitude through large changes in velocity (ΔV) allows repositioning for tactical advantage or geographic sensor coverage. Interchangeable payloads with common interfaces allow tailoring of SMV for a wide variety of mission needs. SMV will use low risk subsystem components and technology for aircraft-like operability and reliability.

Table 5.1. SMV Characteristics and Technology Issues

SMV characteristics
1,200-2,000 lbs. of sensors/payload Rapid turn-time Multi-mission capability 3-12 month on-orbit mission duration Rapid recall from orbit 6-11,000 ft/s on-orbit ΔV

The technology plan for SMV is currently under development, and it will be provided under separate cover.

5.2 SMV Program Funding

The notional funding for the SMV Phase II technology projects is For Official Use Only, and is not discussed in this appendix.

5.3 Technology Programs for SMV

Table 5.3 SMV Technology Programs

PROGRAM
PHASE I
SMV Unpowered Flight
PHASE II
Second Generation SMV Config. Opt.
Recce Systems Operability for SMV
PHASE III
No S&T Programs
PHASE IV
S&T Enhancements

The Acquisition Strategy provides for an evolution of technology throughout the full SMV program. Very few new technology projects are necessary for a successful SMV program. Table 5.3 defines the technology programs for the four acquisition phases of SMV. Funding required for Phase IV projects is not provided, since it is not yet known.

6.0 Common Aerospace Vehicle

The SOV program office will direct development of technology needed for deployment of weapons from the SOV flight vehicle, including the processing and storage equipment. It also includes the ejection system for separating the weapon package from the SOV flight vehicle, and the hardware required to ensure safe delivery of the actual weapon payload to its normal operational flight envelope.

The goal of the ATD is to demonstrate, in flight, that a conventional payload originally developed for air-launch can be delivered accurately to a target via trans-atmospheric flight. The ATD will attempt to simulate a real SOV-like flight profile and weapon package integration configuration (including ejection system). Prior to the flight test, the ATD will also demonstrate many of the operability characteristics of the weapon maintenance and ground operations associated with SOV flight vehicle integration.

Common Aero Vehicle is an integral component of the SOV System architecture. The CAV is a small, powered, maneuvering reentry vehicle that takes a payload from an orbital trajectory, reenters it through the atmosphere, and then safely dispenses that payload in the atmosphere. Payloads on CAV could vary from unattended ground sensors (UGSs) and naval sensors to small unmanned aerial vehicles (UAVs). Ultimately, CAV or CAV-like vehicles could be used to deliver packages to any point on earth in less than 100 minutes. CAV can be employed in the following ways:

- Deliver sensors or UAVs to denied areas.
- Provide interim UAV coverage until deployed assets arrive.
- Rapidly fill gaps in coverage from sensors or UAVs due to equipment failures or combat losses.

- In the future, resupply special operation forces behind enemy lines.

CAV can be delivered directly from an orbital SOV, but would most likely be delivered from a suborbital SOV trajectory. A supplemental rocket motor would boost the CAV to near orbital velocity. The CAV would follow an orbital trajectory, reenter, and use its large crossrange to precisely deliver its payload to the desired location. CAVs tremendous amount of available energy allows it to follow a high "g", unpredictable profile that makes it relatively invulnerable to both conventional air defenses and ballistic missile defenses.

Table 6.1. CAV Characteristics and Technology Issues

CAV characteristics
• Low cost INS/GPS guidance system
• Reasonable crossrange
• Storable liquid propellant engine
• All azimuth launch capability
• Common TPS, aeroshell, guidance
• Popped-up from suborbital demonstrator

6.1 CAV Acquisition Strategy

The CAV Program is directed out of AFRL's SOV System Program at Kirtland AFB, NM with execution and testing support provided by ASC and SMC. A four-phase test and acquisition program is planned. Figure 6.1 shows this plan.

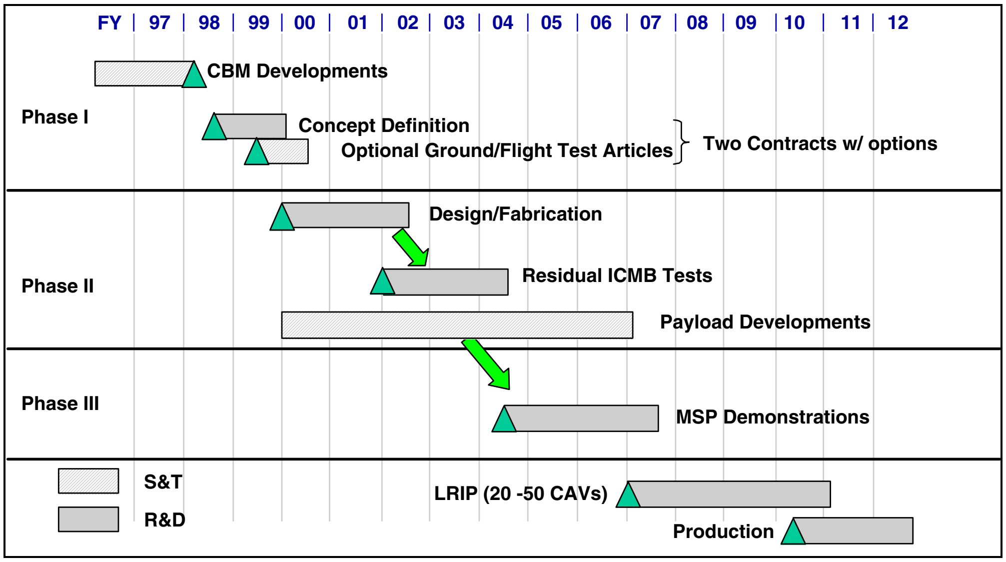

Figure 6.1 Four-Phase CAV Acquisition Strategy

6.1.1 Phase One: Launch flight tests from aircraft

The CAV will be launched aboard a short range ballistic missile (similar to Storm rockets used in the MTD series tests) to test guidance systems, stability and payload release mechanisms. Several tests will be made to demonstrate controllability and guidance system in the Mach 5+ (>3300 mph) and high altitude (>150,000 ft) regime. Crossrange excursions and determinations will be made and system maneuverability demonstrated.

6.1.2 Phase Two: Tests from Minuteman

Long range flight tests. The CAV will be tested using a Minuteman platform to demonstrate the full flight envelope of CAV. A CAV launched from a Minuteman will reach Mach 20+ enroute from Vandenberg AFB to Kwajelein. This test will adequately test thermal protection systems, exo- and endo-atmospheric control, reentry, terminal guidance and payload delivery. Profiles can be chosen to demonstrate CAV trajectory modification to optimize survivability and payload release. A residual operational capability to engage hard and deeply buried targets will result from this phase.

6.1.3 Phase Three: Limited and full production of CAVs.

A CAV will be mated to a booster rocket to push velocity to Mach 22+ and deployed from a suborbital SOV to demonstrate deployment capability from the SOV and rocket motor separation from the CAV. Dispense of payloads from CAV traveling at very high speeds (Mach 3+) will also be demonstrated in this phase.

6.1.4 Phase Four: Limited and full production of CAVs.

Phase IV will see limited, and then full, production of CAVs for the operational Air Force.

6.2 CAV Program

The various funding activities expected for the CAV are For Official Use Only, and is not discussed in this appendix.

6.3 CAV Technology Programs

Table 6.3 Four-Phase Technology Programs for CAV

PROGRAM
PHASE I
No Phase I Programs
PHASE II
CAV Systems Technology
Structures for CAV
PHASE III
Time Critical Target Test Demonstration
PHASE IV
Time Critical Targets Standoff Dispenser

7.0 Modular Insertion Stage

The use of a modular insertion stage (MIS) can provide significantly-enhanced payload capability to most RLV designs. Several hundred percent payload growth is feasible by flying the RLV suborbitally, deploying a payload that is attached to the MIS once the vehicle is at an acceptable altitude. The MIS need not deliver very high performance, but it must be compact, especially if constrained to a very small payload bay volume. The use of an MIS on an ACTD vehicle is necessary to achieve residual operational military capability with the SOV.

The technical objective of the demonstration is the integration, deployment, and operation of a MIS. The demonstration will evaluate key cost, reliability and operability issues of a MIS. Issues related to packaging, handling, storability, hazards, and launch vehicle integration are to be addressed. The demonstration will show suborbital deployment, separation, ignition and at least orbital insertion capabilities.

7.1 MIS Acquisition Strategy

The effort is viewed as a five year, four-phase, $40-70M effort, where launch cost of the demo provides the primary uncertainty in cost. The effort would identify an upper stage design compatible with the ACTD, launchable on a proposed low-cost launcher capable of providing adequate energy for the demo. The stage, any unique ground equipment, and any ACTD vehicle integration equipment will be designed and built. The upper stage will procure all necessary subsystems to make it functional, utilizing as much off-the-shelf hardware as is applicable. System engineering, integration and testing will be allowed for, as well as all demo operations.

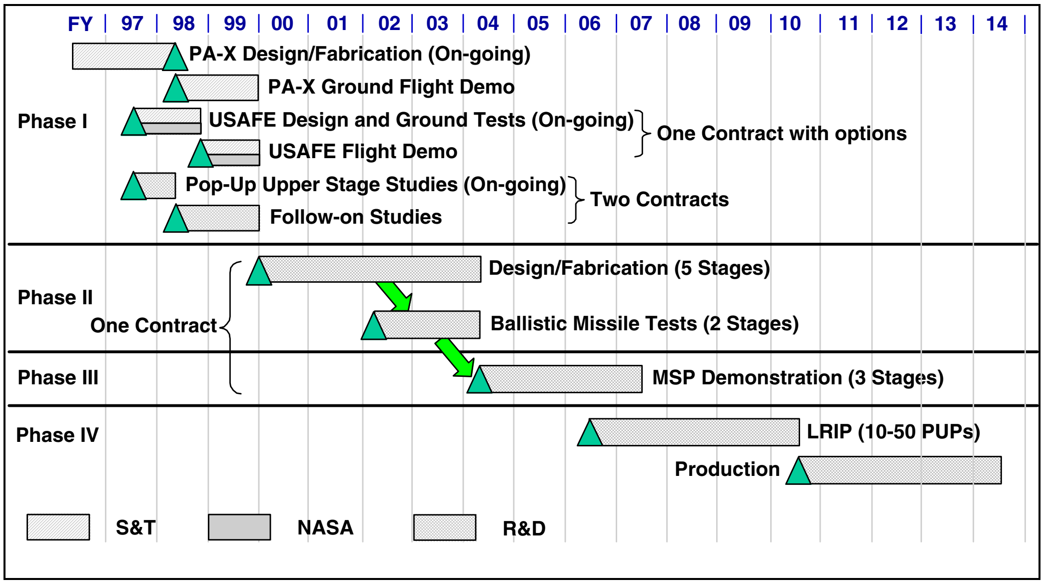

Figure 7.1. Four-Phase MIS Acquisition Strategy

To enable the significant gains in payload from the pop-up concept, a reliable, inexpensive insertion stage is required. To enhance safety, this stage will not rely on hypergols or other potentially dangerous or toxic propellants. Solid propellants are also not desirable because they lack re-light capability. Cryogenic propellants offer excellent performance but cannot be stored for long periods of time due to boil-off problems and cooling requirements. The propellant combination most suitable for an MIS is storable liquid propellants, such as hydrogen peroxide and kerosene (either rocket propellant or jet propellant). With this combination, storage time is virtually unlimited, leaks do not cause fires without an ignition source, throttleability and restartability are excellent, the propellants are dense and thus low volume, and performance is moderate at over 300 secs I_{sp}.

An engine designed for MIS may also be useful for SMV and CAV. For example, a 10 klb thrust engine could be modularized to provide a family of 10, 20, and 30 klb thrust engines by doubling or tripling the turbo-pump sets and other machinery and designing a specialized nozzle for each application. The engine could also be derated to 5-7 klb. thrust for use in high mach pop-ups of smaller payloads such as CAV or tactical satellite. Because of ease of restart and a high degree of throttleability, the MIS can provide all required burns to put satellites into orbits higher than MEO. The initial pop-up burn at 20 klb. thrust can be followed by other burns at lower thrust levels to provide for transfer and circularization. Table 4.7 summarizes MIS applications.

Table 7.1. MIS Applications for 300-320 sec. I_{sp}, 10klb H_2O_2/Kerosene Engine

Vehicle	Application	Thrust Level	Comments
Demonstrator	2-4K lb TACSAT	10 klb	Low "g," relatively fragile
Demonstrator	CAV	10 klb	High "g," robust
Demonstrator	Mini-SOV	20 klb	Medium "g," relatively robust
SOV	CAV	5-7 klb	Full throttle, high "g"
SOV	LEO TACSAT	5-7 klb	Partial throttle, low "g"
SOV	Mini-SOV	10 klb	~One "g" for Mach 21+ pop-up
SOV	Large LEO Satellite	20 klb	Low "g," high Mach release
SOV	GEO/High MEO Satellite	20 klb	Can provide all required burns
SOV	R3M	30 klb	High "g," time critical ops

7.2 MIS Program Funding

The proposed MIS effort follows a four-phase approach consistent with that of the overall SOV System Program. Again, funding particulars are For Official Use Only and not included here.

7.3 MIS Technology Programs

The MIS will require only a minimal amount of technology work prior to execution of demonstrations. In fact, this S&T work is only needed in Phase I of the program. The remainder of the overall MIS development effort is R&D level work that is not addressed in this document. Table 7.1 defines the Phase I efforts for the MIS development.

Table 7.1 Technology Programs for MIS

PROGRAM
PHASE I
PA-X Design / Tech Demo
USAF Flight Demonstration

8.0 Acronyms

ACTD	Advanced Concept Technology Demonstration
AFMC	Air Force Material Command
AFRL	Air Force Research Laboratory
AFSPC	Air Force Space Command
AGINT	Advanced GPD Inertial Navigation Technology
AJ	Antijam
ASC	Aeronautic System Center (RL)
ATACMS	Army Tactical Missile System
ATD	Advanced Technology Demonstration
CAV	Common Aero Vehicle
DOL	Dispersed Operating Location
DSWA	Defense Special Weapons Agency
ELVs	Expendable Launch Vehicles
FRSW	Fast Reaction Standoff Weapon
GPS	Global Positioning System
GTA	Ground Test Accelerator
GTO	GEO Transfer Orbit
HC	Hydrocarbon
HSC	Human Systems Center
HQ	Headquarters
HQ AF	Headquarters Air Force
INS	Inertial Navigation System
IPD	Integrated Powerhead Demonstration
Isp	Specific Impulse (Measured in Seconds)
ITT	Integrated Technology Testbed
KHILS	Kinetic Hardware-in-the-Loop Simulator
LaRC	Langley Research Center
LEO	Low Earth Orbit

LOCAAS	Low-Cost Autonomous Attack System
LOX	Liquid Oxygen
LRIP	Low Rate Initial Production
LRUs	Line Replaceable Units
MCT	
MEO	Medium Earth Orbit
MF	Mass Fraction
MIS	Modular Insertion Stage
MiST	Mini-SOV Technology
MSFC	Marshall Space Flight Center
MTBF	Mean Time Between Failure
MTBO	Mean Time Between Overhaul
NASA	National Aeronautics and Space Administration
NDE	Non-Destructive Evaluation
NDI	Non-Destructive Inspection
OAS	Office of Aerospace Studies
OMS	Orbital Maneuvering System
R&R	Remove and Replace
RLV	Reusable Launch Vehicle
RP	Rocket Propellant
S&T	Science and Technology
SBIR	Small Business Innovative Research
SEAD	Suppression Of Enemy Air Defenses
SiC	Silicon Carbide
SMC	Space Missile System Center
SMV	Space Maneuvering Vehicle
SOA	State of the Art
SOV	Space Operations Vehicle
SRD	System Requirements Document
SSTO	Single Stage to Orbit
TACSAT	Tactical Satellite
TBD	To Be Determined
TPS	Thermal Protections System
TRLs	Technology Readiness Levels
USSPACECOM	United States Space Command
USSTRATCOM	United States Strategic Command
UAV	Unmanned Aerial Vehicle
UGS	Unattended Ground Sensor

VHM	Vehicle Health Monitoring
WES	Waterways Experiment Station
XLR	Experimental Liquid Rocket

[1] Air Force Space Command's Concept of Operations for the Phase I Space Operations Vehicle System, 6 February 1998.

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